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ABSTRACT

Designed as enrichment materials for grades six through nine, this program is an interdisciplinary study of soils. As part of the program students: (1) examine soil organisms; (2) research history of local Native Americans to see how they and others have used the land and its soils; (3) investigate how soils are degraded and how they are conserved for future use; and (4) investigate several critical issues that will affect their lives and the lives of others. "Conserving Soils" consists of 24 spirt duplicating masters, four full-color transparencies, and a 16-page teacher's guide. Each activity master (discussed in the teachers's guide) will produce a minimum of 200 copies. Each of the four transparencies is a full-color illustration, presenting a soil ecosystem, soil profile, soils map, and land use planning map. The teacher's guide contains the background information needed to introduce and teach each lesson. Objectives and suggested activities for getting students actively involved in the learning process are printed on the non-producing side of each spirit master. Techniques include out-of-class research, small group discussion and decision-making, brainstorming, experiments, and case study investigations both in class and outdoors. A glossary of important terms for student and teacher use is also provided. (Author/JN)

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Conserving Soil

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Prepared for: United States Department of Agriculture Soil Conservation Service

By: The Communications and Education Group, A Division of The Mazer Corporation

Introduction

The Soil Conservation Service of the U.S. Department of Agriculture makes *Conserving Soil* available to educators nationwide. Designed for use as enrichment materials in grades 6 through 9, this program is an interdisciplinary study of soils.

Students dig in soils and get their hands dirty. They find the millions of creatures that live under their feet. Students may also research the history of local Native Americans to see how they and others have used the land and its soils. Then they find out not only how we degrade soils but also how we can conserve them for future use. Finally, students investigate several critical soil issues that will affect their lives and the lives of millions of people around the world.

Conserving Soil is ready for use in your classroom. It has 24 spirit duplicating activity masters, 4 full-color transparencies, and this 16-page teacher's guide. With a minimum of effort, you can teach an entire unit that will actively involve students—that will get them away from their desks and into the natural environment. The program contains a balance of in-class and outdoor learning experiences that will teach your students about an often overlooked but essential part of our environment—soils.

Each activity master will produce a minimum of 200 copies. To make copies, detach the master along the perforated edge. Then attach it to the drum of a spirit duplicator and run the desired number of copies. The master can be stored for future use by placing it back in its original place between the tissues.

Each of the program's four transparencies is a four-color illustration. You can write on the transparencies with a grease pencil or a water-soluble marker and remove your markings with a dry or damp towel. (Permanent-ink marker writing cannot be removed.)

Carefully detach the transparency from the guide along its perforated edge, and return it to its original place between the tissues after use.

This teacher's guide contains the background information needed to introduce and teach each lesson. Objectives and suggested activities for getting students actively involved in the learning process are printed on the non-reproducing side of each spirit master. Techniques include: out-of-class research, small group discussion and decision making, brainstorming, experiments, and case study investigations. Optional activities are listed at the end of several lessons.

A glossary of important terms is also included. Photocopy the glossary for your students at the beginning of the unit. Refer to it when you encounter words that are unfamiliar to your students. A resource guide is included at the end of the guide.

Conserving Soil is both interdisciplinary and flexible. Students will use the skills of mathematics, science, English, and social studies curricula. To enhance the effectiveness of this program, you may wish to team teach with a science or social studies colleague.

Comments regarding this program or inquiries about the availability of other conservation materials may be directed to Conserving Soil, U.S.D.A. Soil Conservation Service, P.O. Box 2890, Washington, D.C. 20013. You may also write to this address for a free color land resource map of the United States. It would be an excellent map to use with this program.

Soils Glossary

Acid Rain—Rain, snow, or other forms of water that are made more acid by waste gases which come mainly from the burning of coal and oil products. The gases (usually sulfur dioxide and oxides of nitrogen) mix with water and other materials in the air. Acid rain falls on the land and water and can affect wildlife, plants, soil, and building materials.
Acre—A unit of measurement of land. It is equal to the area of land inside a square that is about 209 feet on each side (43,560 square feet).
Algae—Microscopic green plants that live in water and on land. They serve as food for other organisms.
Bacteria—Microscopic organisms that live on water and on land. They help break down organic materials into simpler nutrients in a process called decay. Bacteria release nutrients to the soil.
Bedrock—A more or less solid layer of rock found on the surface of the land or below the soil.
Cell Division—The process by which a plant or animal cell splits in half to form younger cells.
Commodity—A useful or valuable product of agriculture such as soybeans, beets, or cattle.
Composting—Mixing decaying organic matter (food scraps, grass clippings, leaves) to form a rich soil conditioner.
Condensation—Changing a gas into a liquid; for example, when steam or water vapor turn into water.
Elongation—The process in which something becomes longer, such as plant cells as they grow.
Evaporation—Changing a liquid to a gas; for example, when water turns into steam or water vapor.
Export—A product (such as grain or meat) that is traded with another nation.
Famine—An extreme shortage of food in a given area.
Feedlot—An enclosed area in which animals such as hogs or cattle are fed before being sold for meat.
Fungi (plural of fungus)—A group of non-green plants, such as molds, and mushrooms, that live on dead or dying organic matter. Fungi release nutrients to the soil.
Goods—An item or thing, such as bread, meat, or fruit, that people are willing to buy.
Habitat—An area of land in which plants and animals live, grow, and reproduce.
Humus—Highly decomposed plant and animal residue that is a part of soil.
Hydrologic Cycle—The cycle of water movement from the atmosphere to the earth and back again through these steps: evaporation, transpiration, condensation, precipitation, percolation, runoff, and storage.
Irreversible—A situation that is impossible to change. For example, it is impossible to change a shopping mall back to farmland.

Land–One of the major factors of production that is supplied by nature and includes all natural resources in their original state such as mineral deposits, wildlife, timber, fish, water, and the fertility of the soil.
Landfill–A location where solid waste (garbage) is disposed of.
Leaching–The removal of soluble minerals from soil by the downward movement of water.
Mineral–A naturally occurring inorganic substance with definite chemical and physical properties and a definite crystal structure.
Monoculture–The cultivation of a single type of crop over a large area which excludes other uses of that land.
Native Americans–The people who lived in the United States before it was inhabited by people from Europe, Asia, and other continents.
Nematodes–Microscopic, elongated worms that live on other organisms in the soil.
Nutrient–A substance that supplies nourishment for an organism to live. It can be food or chemicals depending upon the organism.
Nutrient Exchange–The process by which plant roots exchange an acid for nutrients from the soil.
Organic Matter–Plant and animal material in various stages of decomposition that may be part of the soil.
Parent Material–The earthy materials—both mineral and organic—from which soil is formed.
Percolation–The downward movement of water in soil.
Permeability–The quality of soil that allows air or water to move through it.
Photosynthesis–The process in which green plants combine water and carbon dioxide gas in the presence of light to form sugars and oxygen gas.
Plains States–The area of the United States that is generally west of the Mississippi River and east of the Rocky Mountains (also called the Great Plains).
Pore Spaces–The area of the soil through which water and air move. The space between soil particles.
Precipitation–Rain, snow, and other forms of water that fall to earth.
Productivity–The amount of crops or animals that can be harvested from land. It can also mean the general amount of goods made in a given time or in a given area.
Respiration–The process by which organisms obtain energy when sugars combine with oxygen. Carbon dioxide and water are given off.
Row Crops–Agricultural crops, such as corn and soybeans, that are grown in rows.
Runoff–Water that flows off land into streams and other waterways.
Soil–A naturally occurring mixture of minerals, organic matter, water, and air which has a definite structure and composition and forms on the surface of the land.
Soil Color–The color of a sample of soil.
Soil Horizon–A layer of soil that is nearly parallel to the land surface and is different from layers above and below.
Soil Mineral–That portion of the soil that is inorganic and neither air nor water.
Soil Survey–The identification, classification, mapping, interpretation, and explanation of the soil over a given area of land.
Soil Texture–The relative amounts of sand, silt, and clay in a given soil sample.
Technology–The many different methods used to provide goods for human needs and wants.
Water Storage–The locations in which water is stored. They can be above ground in lakes, rivers, and other waterways or below ground as ground water.
Zone of Accumulation–The layers in a soil into which soluble compounds are moved and deposited by water.
Zone of Decomposition–Surface layers in a soil in which organic matter decays.
Zone of Leaching–The layers in a soil from which soluble nutrients are removed by water.

Unit I

Soils: An Overview

In this unit, students investigate the fundamental concepts of soil science and survey the social and economic impacts of soils. This unit makes no attempt to deal comprehensively with the topic. Instead, it presents a few key concepts to form the basis for expansion in Unit II, where students investigate the proper use of this valuable natural resource.

There are two lessons in Unit I. "Soil Science" looks at soils from an investigative point of view. Students collect and analyze samples of many different types of soil. "The Social Impact of Soils" highlights the important role that soils had in the history of the United States and still have in our lives. Students look back to a time when Americans lived directly from the soil. They also contrast that period with today when most Americans are removed from the soil itself, but still depend on it for food and fiber.

Lesson 1

Soil Science

This lesson introduces students to the soil beneath their feet. They find out what soils are and what types of creatures live underground. They also learn how a soil is formed and how soils differ. Students spend time outside in a laboratory setting.

Lesson 1 offers several opportunities to reinforce science methods. Encourage your students to observe carefully, to record data accurately, and to inquire and discover scientifically why soils are such an important part of the environment.

Lesson 1 consists of five activity masters and two transparencies.

Activity Master 1

Soils: What Are They?

Soil. Earth. Dirt. No matter what we call it, it's the material that constitutes the outermost solid layer of the planet. We build on it. We raise food in it. We mine minera, resources from beneath it.

Apparently unchanging and lifeless, soils are dynamic mixtures, teeming with life. One teaspoon of soil in the temperate regions can contain billions of organisms ranging from simple bacteria and fungi to more advanced forms. Earthworms, insects, and

spiders are examples. Bedrock is continually fractured, dissolved, and changed into soil; but the process occurs slowly so we usually never notice.

Soil is a naturally occurring mixture of mineral and organic ingredients with a definite form, structure, and composition. The exact composition of soil changes from one location to another. The following is the average composition by volume of the major soil ingredients:

45% Minerals (clay, silt, sand, gravel, stones)

25% Water (the amount varies depending upon precipitation and the water-holding capacity of the soil)

25% Air (an essential ingredient for living organisms)

5% Organic matter or humus (both living and dead organisms)

A soil is composed primarily of minerals which are produced from parent material that is weathered or broken into small pieces. Beyond occasional stones, gravel, and other rock debris, most of the mineral particles are called sand, silt, or clay. These mineral particles give soil texture. Sand particles range in diameter from 2mm to 0.05mm, are easily seen with the unaided eye, and feel gritty. [One millimeter (mm) is about the thickness of a dime.] Silt particles are between 0.05mm and 0.002mm and feel like flour. Clay particles are smaller than 0.002mm and cannot be seen with the unaided eye. Clay particles are the most reactive mineral ingredient in the soil. Wet clay usually feels sticky.

Water and air occupy the pore spaces—the area between the mineral particles. In these small spaces, water and air are available for use by plants. These small pore spaces are essential to the life of soil organisms, to soil productivity, and to plant growth.

The final ingredient of a soil is organic matter. It is composed of dead plant and animal material (detritus) and the billions of living organisms that inhabit the soil.

In this activity, students collect soil samples, examine them, and compare samples with classmates.

Activity Master 2

Soil Ecology: Plants and Animals Under Your Feet

Plants and animals have important roles to play in soil. Both plants and animals change the composition and structure of soil in many different ways.

Plants with roots obtain nutrients and moisture from soil through their roots. The hard and durable root cap, located on the tip, protects the growing root. In the area immediately behind the root cap, cells are rapidly dividing to form new cells. This is called the region of cell division. Behind this area, cells elongate—grow longer. This is called the region of elongation. The combination of cell division and elongation creates great pressures that push the root through the soil. These pressures are often great enough to cause large boulders to fracture if a root grows into a crack.

Roots get energy to grow from sugars that are made during photosynthesis—a process that occurs in the leaves. As the roots grow, they use oxygen from the surrounding pore spaces for respiration. The carbon dioxide given off reacts with soil water to form weak carbonic acid.

Roots absorb nutrients and water primarily through tiny projections called root hairs. This is called the region of absorption. Soil water places the root hairs in chemical contact with nutrients that are on the surface of clay and humus particles. The weak carbonic acid clinging to the root hairs provides hydrogen ions to the soil water. The hydrogen ions then exchange with chemical nutrients from the surfaces of soil particles. These nutrients, including ions of magnesium, calcium, sodium, potassium, phosphorus, and nitrogen, are absorbed by root hairs. The chemical ion exchange, called nutrient exchange, occurs continuously around the roots.

Although plants are the most visible large organisms, many animals also inhabit soils. Earthworms are perhaps the best known of this group. Scientists estimate that between 200 and 1000 pounds of earthworms can be found in an acre of soil. Aristotle called them "the intestines of the earth." Earthworms eat organic matter and any other soil particles that get mixed in. They digest the organic matter and pass nutrient-enriched soil through their bodies. This recycles nutrients and makes soil richer. In addition, their tunnels allow air and water to penetrate the soil more rapidly. In short, earthworms—like many other organisms—are vital to soils. They keep them rich and productive.

In this activity, students examine the role of plant roots in soils and they label a diagram of an enlargement of a root tip. In addition, students search through soil samples for living plant and animal organisms.

Additional Activities

1. Demonstrate plant root growth by lining the inside of a pint or a quart jar with paper towels. Fill the jar with peat moss, cotton, vermiculite, or sawdust. Pour an inch of water in the jar and place bean, pumpkin, or corn seeds between the paper and the jar. Keep the jar warm and moist. Have students observe plant growth.

2. Obtain two flat 8" square pieces of glass or Plexiglas. Lay several thicknesses of paper towels on one piece of glass. On the towels place several ryegrass, radish, or carrot seeds. Place the second glass on top, then tie with string or rubber bands. Secure the glass plates at a perpendicular angle in a dish of water. When the seeds sprout, observe the root hairs and growth with a magnifying glass.

Transparency 1

The Soil Ecosystem

The transparency illustrates a close-up of a hypothetical soil, including living organisms, a circular enlargement of microorganisms, and the

nonliving components of soils. The top portion of the circular enlargement is about 50X normal size; the center, about 150X; and the bottom, about 300X. This transparency is used with Activity Master 2 to demonstrate the components of soil and the types of organisms students should see in the samples.

Teachers should explain that the soil in this transparency differs from soils in deserts, marshes, and cold climates for example. Contact your local Soil Conservation Service office for more information if local soils differ greatly from the example in the illustration.

Activity 3

How Is a Soil Formed?

There are thousands of different soils throughout the world. Weakly developed, moderately developed, and well developed soils are formed through a combination of five important factors.

Parent Material

Parent materials are the earthy materials, both mineral and organic, from which soil is formed. Parent material can be a volcanic deposit such as ash that fell upon an area. It can be a sediment that has been transported and deposited by wind or water, or a deposit left by glaciers. Weathered bedrock can also be parent material. Moderately and well developed soils are made when a parent material is changed both chemically and physically over time.

Climate

Parent material is broken down into finer particles by a process called weathering, which is controlled by the climate of a given location. Temperature and water are major climatic forces that influence weathering.

Frequent freezing and thawing will cause water trapped in cracks to expand, exerting pressures which fracture the rocks and smaller materials even further. Alternate wetting and drying also break down particles because not all minerals expand and contract at the same rate. Further, water tends to dissolve certain minerals from parent material.

Living Organisms

Both plants and animals help to create a soil. As they die, plants and animals add organic matter to weathered parent material to help form subsoil and topsoil. Plant roots also alter the soil in the ways that were mentioned in Activity 2.

As animals dig through the soil, they break it up, permitting more air and water to enter. They mix the organic matter throughout the soil. Smaller plants and animals—bacteria, fungi, and nematodes, for instance—also enrich soil by breaking down organic matter into simpler nutrients. The actions of plants and animals help form topsoil on moderately and well developed soils.

Topography

Topography is the hilliness, flatness, or amount of slope of the land. Soils vary with topography primarily because of the influence of moisture and erosion. In many areas, moist, poorly drained soils are located in low areas, and depressions of the land. In contrast, soils in sloping areas can be drier and well drained. These soils tend to be moderately and well developed. Erosion can remove all or part of the topsoil and subsoil, leaving a weakly developed soil.

Time

The age of a soil must be considered in thousands and even millions of years since it may take hundreds of years for these factors to form one inch of soil from parent material.

In this activity, students read a fact sheet about the five factors that produce soils.

Activity 4

What Are Soil Horizons?

Soils develop into layers. These layers, called horizons, are usually seen along road cuts and other areas where the soil is exposed. In the hypothetical situation, there are four horizons in a soil profile. The thickness of each varies with location, and under disturbed conditions—heavy agriculture, building sites, or severe erosion, for example—not all horizons will be present.

The uppermost is called the organic horizon or O horizon. It consists of detritus, leaf litter, and other organic material lying on the surface of the soil. This layer is dark because of the decomposition that is occurring. This layer is not present in cultivated fields.

Below is the A horizon or topsoil. Usually it is darker than lower layers, loose, and crumbly with varying amounts of organic matter. In cultivated fields the plowed layer is topsoil. This is generally the most productive layer of soil.

As water moves down through the topsoil, many soluble minerals and nutrients dissolve. The dissolved materials leach from the topsoil. In fact, the A horizon is a zone of leaching.

Below is the B horizon or subsoil. Subsoils are usually light colored, dense, and low in organic matter. The subsoil is a zone of accumulation since most of the materials leached from the topsoil accumulate here.

Still deeper is the C horizon. It is a transition area between soil and parent material. Partially disintegrated parent material and mineral particles may be found in this horizon. The final horizon is bedrock.

In this activity, students learn about the four soil horizons and examine the soil in each horizon of a soil profile.

Transparency 2

A Soil Profile

This transparency illustrates a hypothetical soil profile. The illustration shows clearly defined and labeled O, A, B, and C horizons with readily identifiable features, for instance: rocks, twigs, roots, etc. This transparency is used with Activity Master 4 to demonstrate the processes that form soil horizons.

Activity Master 5

How Do Soils Differ?

Although soils consist primarily of sand, silt, and clay, there are over 70,000 different types of soils around the globe. There are many characteristics that differentiate one soil from another; for example, amount of nutrients available, erosion potential, and permeability. Physical characteristics are the easiest to observe and by examining only a few, several generalizations can be made about soil. Two important physical characteristics (or traits) are color and texture.

Color

There are three color categories of topsoil which relate to the amount of organic matter:

1. **Dark soils.** Dark soils are black, dark gray, or dark brown. Rich in organic content and usually very fertile, dark soils have a high degree of aeration (there is plenty of pore space for air). Since water soaks easily into these soils, they are slow to erode. They are excellent for gardening and agriculture.

2. **Moderately dark soils.** Colors range from brown to yellow-brown in these soils. They have a moderate amount of organic matter and are of medium fertility. They contain an average amount of aeration and are slightly erodible. With proper agricultural methods, moderately dark soils can be good for farming and gardening.

3. **Light colored soils.** Pale brown to yellow colored soils are usually poorest for farms and gardens. They are low in organic matter, fertility, and aeration. Further, they are often highly erodible.

Texture

Soils can be classified into three groups by texture: clayey, sandy, and loamy. To test for texture, wet a small amount of soil and rub it between your fingers.

Clayey soils are very smooth and sticky. Sandy soils are very gritty. Loamy soils are between these two extremes: they are smooth, slick, and partially gritty and sticky.

Clayey soils are usually dense but can hold much water. Yet the water is held so tightly it is less available for plants. Loamy soils are loose and crumbly and are well aerated. They hold water quite well for use by plants. Sandy soils are loose and crumbly. They are so porous that there is little water for plants.

In this activity, students use the physical traits of color and texture to analyze soil samples.

Additional Activity

Obtain commercial soil testing kits and analyze samples for the concentration of nitrogen, potassium, and phosphorus (three vital plant nutrients) and for pH. Testing kits can usually be found in high school science departments. You could also ask an agricultural specialist from the county cooperative extension service to demonstrate soil sampling to your class.

Lesson 2

The Social Impact of Soils

In contrast with Lesson 1, "Soil Science," this second lesson investigates the social aspects of the land and the soils and how we use these resources. Students discover that most of the items we buy, use, and eat came from soils—even a simple pizza. Students also learn how Native Americans in their community used the soils years ago. Students contrast this use with our present use. Finally, students research how soils have influenced the history of the United States.

There are three activity masters in this lesson.

Activity Master 6

We Depend Upon Soils

Each person cannot produce all of the food, obtain all of the energy sources, or manufacture all of the products used in our modern society. A system of producing goods has evolved to supply these basic requirements. Often this system involves many steps between extracting the resource from the land and using the manufactured product at home. Many soils throughout the world are affected.

Producing the goods we use can be categorized into two procedures: obtaining, then processing resources. First the resources are obtained from the land and its soils. For example, vegetables are grown in soil. Animals are raised on grasses, grains, and soybeans that are grown in soil. Mineral resources—coal, iron ore, petroleum, and many others—are mined from beneath the soil and the bedrock below.

Processing, the second procedure, usually occurs in industrialized locations that may be far removed from the resource. The end result of the various steps in processing is a consumer good and usually waste by-products that need to be recycled or discarded.

Consider, as an example, the production of an aluminum beverage can. The can started as a mineral resource, bauxite ore. Since we must import most of this ore, the can probably began in a foreign nation such as Surinam in South America. After it arrived in the United States, the ore was smelted into aluminum metal. Then the metal was formed into beverage cans and filled.

Nine thousand miles from Surinam, with one kilowatt-hour of electricity invested in its processing, the aluminum can is ready to be purchased. Most of the products we buy are obtained through such a system of production. And every product is obtained either directly or indirectly from the land and its soils. In our complex society, not only local soils, but soils across the world are affected by the items we purchase.

In this activity, students investigate the steps required to produce several goods and they identify soil as one natural resource common to all consumer products.

Additional Activity

Your class could investigate the resources required and the steps involved in manufacturing a

automobile. As students found in their study of the pizza, resources needed to manufacture cars also come from land and soils.

Activity Master 7

How People Have Used Soils

People have always used the plant and animal resources of the land to supply themselves with food and shelter. This is just as true today as it was when the land now designated the United States was inhabited by Native Americans.

The ancient Native Americans had a limited technology to alter the land and soils to produce items they needed. In general, their cultures evolved to fit the environment. For instance, in areas of favorable climate and soils, local tribes established a stable agrarian culture with organized villages. Some tribes even irrigated their fields. In harsher locations, for example Alaska and the Great Plains, a nomadic lifestyle usually developed. Individual tribes followed the primary food sources of seal and whale in Alaska and buffalo on the Plains. Agriculture in both areas was difficult. These nomadic cultures had little effect on the land since they lacked the technology to alter large areas of the environment.

In contrast, modern technology can alter the land and the soil in both beneficial and detrimental ways on a massive scale. For example, large-scale, intensive monoculture of grain crops and extensive urbanization can be detrimental. These practices increase the erosion potential and can deplete the soil, or remove large acreages from farming. Conservationists have learned much about soil erosion and flood control and have made advances in reducing these problems. However, for various reasons erosion is still a very severe problem.

With our tremendous technological ability to alter land and soil comes a responsibility. This responsibility must be seriously considered to balance the benefits of the land use with the possible detriments it may cause.

In this activity, students research the Native Americans who lived in their community. They also investigate our ability to help and harm the land and the need to make careful decisions.

Additional Activity

Your students could produce a slide program or a videotape on the Native American cultures that existed in your area. The presentation should highlight the interaction of the Native Americans with the land.

Activity Master 8

U.S. History Was Affected by Soils

The land is the surface of the earth and all its natural resources: the plants, the animals, the underlying minerals, and, most important, the soils. Plants grow in soil and ultimately animals depend upon the nourishment of these plants. Thus, the plants, animals, and minerals are products of the soil: a more basic resource than any of the others.

The land and the soil have had a dramatic effect upon United States history. In the 1500's and the 1600's the New World was viewed as a utopia, a land of abundance. This was due primarily to reports of rich, fertile soils and vast amounts of timber, fur pelts, and other resources that could be obtained from the land and the soil. This perception of abundance continued throughout our very early period of settlement and expansion when many nations claimed large tracts of American land. The perception of abundance and plenty lasted through the Revolutionary War period and culminated in the 19th century.

Many, including our government officials, believed it was our nation's right and duty to expand and to reap the benefits of the land and the rich soils of the West. The expansion was judged essential to meet the needs of a young, growing nation. Pioneers moved west seeking flat, fertile land at little or no cost.

Although the trip was rough and the life on the Plains difficult, land rushes, the Homestead Act, and several inventions urged settlers ever westward. Three key inventions during this period were the steel plow, barbed wire, and the windmill. Barbed wire helped control the grazing of cattle on cropland and windmills provided water for parched soil and livestock. But the steel plow, which made it possible to break up the tough matting of the prairie grasses, is the invention that did more than anything else to spread the intensive agriculture that has been practiced on the Plains ever since. During this period agriculture changed. It was no longer subsistence level because farmers were selling crops. This was the beginning of modern agribusiness.

When the railroads ventured west of the Mississippi River they carried the products of western soils—cattle and grain—to their market in the rapidly industrializing East. Clearly, the land and its rich soils have had a remarkable impact on U.S. history.

In this activity, students research the historical periods of the 1600's and the 1850's to determine the people's perception of the land and soil.

Additional Activity

Inform your students that they are stranded on an island and can have only 10 items with which to survive indefinitely. In small groups, have students select the items and rank them in order of importance. Discuss the lists and the reasons for selecting the items. Several of the items should enable students to establish agriculture on the island.

Unit II

Managing and Conserving the Soil

In this second unit, your students build upon the basic soil science concepts learned in the first unit and apply the knowledge in two lessons. In the first lesson, "Soil Degradation," students investigate how human activity tends to degrade or reduce the quality of soils. Students search for examples of soil erosion and write about the Dust Bowl. In "Soil Conservation," the second lesson, students examine the reasons and methods of soil conservation. They also research the services offered by the local offices of the Soil Conservation Service and the conservation district and read simplified soil maps to evaluate land use practices.

Lesson 1

Soil Degradation

This first lesson of the second unit introduces your students to soil degradation—how soil quality and productivity are reduced. They find out the different ways that human activity tends to degrade soils through improper use. Students also closely examine the five types of soil erosion—sheet, rill, gully, wind erosion, and land slippage. The lesson concludes when students examine the Dust Bowl and the effects of this runaway erosion on people.

During this lesson, your students can contact local government officials (county engineer, council members, commissioners, etc.) to determine what the local soil degradation problems are. In addition, your students can ask what can be and is being done to solve them.

Lesson 1 consists of four Activity Masters.

Activity Master 9

How We Degrade Soils

The quality of soils can be reduced by human actions. Soil degradation usually occurs because people do not understand soils and how they act under various conditions. Often poor decisions are made and soils cannot support a particular land use practice. Such soil degradation can occur in both rural and urban locations.

When a farmer removes an agricultural crop from a field, the soil can degrade. The tires of heavy equipment may compact the soil. If the whole plant is removed, valuable organic matter is lost. These actions can reduce not only the nutrients available in the topsoil but also the ability of the soil to hold water and air. In addition, a plowed agricultural field left without plant cover will erode more rapidly. Certain agricultural chemicals, like pesticides, can also build up in the soil. In short, highly mechanized, intensive agriculture without proper soil conservation tends to reduce soil quality. Farmers must spend more time and money to raise crops on the poorer soil.

In urban areas, soils are also degraded by human activity. For example, on construction sites, all trees and other vegetation are often removed, exposing the soil to erosion. Homes, factories, and roads are built on the land. This land, for practical reasons, can never again be used for agriculture. Large landfills are dug in the soil to dispose of our waste materials. This practice can also remove land from productive agriculture.

Food is our largest export commodity. In many nations the lives of millions of people depend on our food and the productivity of our soils.

Rural land in this country, some of it our best cropland, is being converted to other uses at an estimated 675,000 acres per year. In the late 1960's and early 1970's when land conversions were at their peak, the annual loss of all types of rural land to various kinds of nonfarm uses ran as high as 3 million acres. Current estimates place the loss at a lower figure today, since dams, rural airports, highway interchanges, and large housing developments are not being built as rapidly.

At a time when food is so important to the world, we must preserve the quality and quantity of soils. We must carefully protect soils and conserve agricultural land.

In this lesson, students match several facts about soil degradation to related problems.

Activity Master 10

Soil Erosion: How It Occurs, Part 1

Erosion is the process which moves soil from one location to another by wind, water, or other natural action. It is a natural process until accelerated by our actions. It has several harmful effects. Farmers harvest a smaller crop per acre, fields become less productive if large gullies develop, and silt from eroded soil builds up in our waterways, causing more frequent flooding and higher costs for navigation. Costly dredging is often required to correct silt problems.

It is usually easy to find evidence of soil erosion that is caused by moving water; soil scientists have identified three types: sheet, rill, and gully.

Sheet Erosion

Sheet erosion is the most difficult to see. It is the gradual wearing away of a thin, uniform layer (or sheet) of soil. There are no channels formed by the moving water. Sheet erosion occurs where there is not enough vegetation covering the soil to stop erosion completely, yet there is enough cover to prevent rill erosion. It is seen as muddy runoff water.

Rill Erosion

This type of erosion occurs on slopes where the runoff water accumulates into small channels. Rill erosion can be seen as many small channels of a few inches depth. Yet the channels are not large enough to interfere with the movement of farm equipment. Rill erosion occurs on slopes that are gentle or have little protective vegetation.

Gully Erosion

Gully erosion is the most dramatic form of soil erosion. Gullies form when the runoff water accumulates into channels. The rapidly moving water causes the channel to grow wider and deeper. Gullies may become too deep for farm equipment to cross. Gully erosion occurs on steeper slopes which have little or no vegetation.

Although gully erosion is the most evident, sheet and rill erosion are a greater national concern. Sheet and rill erosion remove an average of 5 tons of soil from every acre of cultivated cropland each year. (A pickup truck can hold about 1-2 tons of material; and an acre is about the size of a football field.)

In this activity, students search for examples of sheet, rill, and gully erosion in their communities. They tell why it occurs and how it can be reduced.

Additional Activity

Create a classroom display of sheet, rill, and gully erosion. Use three shallow, plastic-lined boxes filled with local soils. Fill the boxes with soil and appropriately mold the soil to illustrate the three forms of erosion.

Activity Master 11

Soil Erosion: How It Occurs, Part 2

In addition to sheet, rill, and gully erosion by water, soils are eroded two other ways. Wind erosion and land slippage also cause soils to move from one location to another.

Most wind erosion occurs in areas of high prevailing wind speeds and low annual rainfall. The soils have a smooth surface and are composed of particles that are easily moved by the wind. In addition, there is limited vegetation cover. Wind erosion is a particular worry on the Plains, where these conditions may exist over large areas of cropland and rangeland. For example in Texas, which has the greatest land area subject to wind erosion, this area is larger than the total combined areas of Ohio, Indiana, Illinois, and Iowa.

A good way to control wind erosion is to plant a cover crop or windbreak that decreases the speed of the wind at the soil surface. Windbreaks can be rows of evergreen trees planted at a perpendicular angle to the wind, narrow bands of tall grasses, or grasses planted in fields instead of row crops.

Land slippage refers to blocks of saturated soil moving down slopes in response to gravity. It is usually seen as a cave-in of a cliff or bluff that overhangs a river or stream. Land slippage can also be seen as small landslides or mudslides along steep road embankments. The famous mudslides of southern California that damage homes and roads are recurring examples of land slippage. Less evident examples can be seen along cultivated fields. Blocks of soil tend to creep down slopes during the winter from frequent freezing and thawing.

In this activity, students identify local wind erosion and land slippage problems. In addition, they rank their impression of the soil erosion damage in their community.

Activity Master 12

Soil Erosion: How It Affects Us

Almost no one benefits from soil erosion. It is costly to us all. It often raises the price of food. It increases the possibility of flooding. It increaes the need for dredging of our waterways. The most dramatic example of how soil erosion can affect the individual and society occurred during the 1930's—the Dust Bowl.

Before the 1930's much of the tough, drought-resistant grasses that grew naturally in the Plains States were plowed under. In place of these grasses —which were ideally suited for this environment— corn and wheat were planted. These crops were less drought-resistant and could not protect the soil from erosion as effectively as the native grasses. In addition, some of the rangeland in the Plains was overgrazed by cattle and sheep. This left weakened vegetation and bare soil.

In 1931 the first of several severe droughts of that decade hit the region. Crops failed as the weakened plants died. Vast areas of bare soils were exposed to the strong prairie winds. The autumn of 1933 marked the first of many dust storms. Soil was picked up and blown as far away as Washington, D.C., and to other East Coast areas. From two inches to one foot of topsoil were lifted and eventually piled up over roads, houses, farm equipment, and trees. The summer temperatures were hot, the weather dry, and the sun shown blood red through the gray haze caused by the dust.

The worst erosion occurred in parts of Colorado, New Mexico, Kansas, Oklahoma, and Texas. Out of disgust and despair, thousands of farm families left the Dust Bowl areas. Some of them headed west to California and its lush, green agricultural valleys. Some became migratory farm workers living in encampments as they followed the harvests. Many eventually found jobs in cities or started over in farming.

In his novel *The Grapes of Wrath*, John Steinbeck described the dust storms and the effects of runaway erosion on people.

In this activity, students learn how the severe erosion affected people during the Dust Bowl. Students then write short stories based on their findings.

Additional Activity

Have several students tape record a dramatic reading of the first chapter of *The Grapes of Wrath* by John Steinbeck. Or obtain a professional recording or a film and play it for your class. You could also play portions of recordings by Woody Guthrie entitled "Dust Bowl Ballads" or any of his interviews with the Library of Congress.

Lesson 2

Soil Conservation

This lesson first examines the philosophic and economic reasons for conserving soil and minimizing its degradation. Next students learn how soil and water resources can be properly managed. Finally students investigate simplified soil maps on Transparencies 3 and 4. They also locate soil convervation problems and practices in their communities.

This lesson uses six activity masters and two transparencies.

Activity Master 13

Why Conserve Soils?

There are many reasons why we should conserve soils, so many in fact that it is helpful to describe only categories of reasons.

Humanitarian Reasons

These reasons concern human welfare and social reform, in particular providing an adequate supply of nutritious food for the hungry. The U.S. has traditionally been the largest contributor of food aid to developing nations. Food constitutes about 30 percent of all our foreign aid. Providing enough for exports, food aid, and domestic use requires a high soil productivity.

Economic Reasons

Economic reasons concern expenses incurred on the farm to produce food, the costs of goods to the consumer, and exports. The U.S. is the world's leading exporter of agricultural products. Maintaining high levels of exports will help match trade deficits to foreign countries and help strengthen our economy. (Trade deficits occur when the value of our imports exceeds the value of our exports.) Our recent high volume of imported oil has helped create a trade deficit.

Stewardship Reasons

Stewardship refers to our responsibility to manage natural resources to assure an adequate supply for future generations. Stewardship connotes the practices of wise use, conservation, and preservation.

Environmental Reasons

Soils should also be conserved for environmental reasons. It is a societal benefit to have a clean environment with adequate supplies of pure drinking water, clean air, productive soils, and recreational areas.

Aesthetic Reasons

This final category concerns maintaining the environment as a beautiful site to experience. Most people would like to avoid unsightly scars and bare, eroded soils on the landscape.

In this activity, students answer fill-in-the-blank questions to learn why we should conserve soils. They then categorize the reasons into five areas.

Activity Master 14

Managing Soil Resources

Three cooperating agencies have the primary responsibility for helping citizens manage soil resources. One is the Soil Conservation Service (SCS) of the U.S. Department of Agriculture (USDA). Although SCS is headquartered in Washington, D.C., most of its employees are located in offices in each state and in almost every county.

Another USDA agency, the Agricultural Stabilization and Conservation Service (ASCS), provides cost-sharing to land users for conservation work.

On the local level, a soil conservation district (also called soil and water conservation district or conservation district) directs soil conservation efforts. All were formed as a direct result of the Dust Bowl era. They work together to help identify and solve local soil conservation needs.

The Soil Conservation Service was formed in 1935. Its mission is to conduct soil surveys and to recommend and demonstrate soil conservation methods. SCS also publishes information materials on soils and soil conserving methods. In addition SCS provides funds for implementing local soil and water management plans.

The soil conservation district concept began with the idea that the local people who owned the farms and ranches best understood local soil needs and problems. Therefore, local people should be in charge of local soil conservation planning. In February 1937, President Franklin Roosevelt urged all governors to pass laws permitting soil conservation districts. Arkansas was the first to do so; today all states, Puerto Rico, the Virgin Islands, and the District of Columbia have conservation districts.

The soil conservation district is a state governmental subdivision with boundaries usually the same as the county. The district is governed by locally appointed or elected men and women who are responsible for planning, approving, and implementing conservation projects.

In this activity, students read about the history of SCS and the conservation districts and determine the services offered by their local offices.

Activity Master 15

Managing Water Resources

A watershed is all of the land area that drains into a particular stream or stream system. It is outlined by the highest ridges around the stream. The water flows through the watershed in the hydrologic or water cycle.

The hydrologic cycle begins as evaporation. First water evaporates from surface and underground water storage. It is also lost as vapor from the leaves

of plants through transpiration. When the water vapor rises, it cools and eventually condenses into clouds. When enough water vapor condenses, it finally falls back to earth as precipitation. The water may run off into waterways or lakes as surface storage. Or, it can percolate (seep) through the soil into ground water storage. Then the water is lost by evaporation and transpiration—completing the hydrologic cycle.

Soils are the major reservoir of usable water for plants. If a soil is rich in organic matter and has a cover crop or mulch, most of the precipitation will percolate into the soil for plant use. But if the soil surface is bare, hard, and crusty with little organic matter, most of the precipitation will run off into streams, carrying sediment, and there is less water available for plants. Periods of heavy rains increase erosion, silt buildup in the larger waterways, and the possibility of flooding.

Managing the soils within a watershed not only controls erosion, but also helps keep silt out of the waterways. Poor soil management upstream generally results in water quality degradation downstream.

The goal of proper water management within a watershed is to decrease the rate and volume of runoff so that water can percolate into the soil as fast as possible. And one of the best ways to do this is to maintain soils rich in organic matter and soil organisms, and to practice soil conservation methods.

In this activity, students outline a watershed on a map and answer questions about soil and water conservation within the watershed.

Additional Activities

1. Demonstrate how rapidly water percolates into the soil on the school yard. Remove the ends of a large juice can, place a board on top of the can, and tap the can down into the soil to a depth of about two inches. Do not disturb the soil or plant material. Add one quart of water, and immediately measure the depth in the can. Then measure the depth of water in the can every minute for the first ten minutes and at ten-minute intervals until the water has drained. Students should plot a graph of depth of water vs. time. Conduct similar experiments in several different soil conditions: on a compacted path, in a grassy area, etc. Discuss the role of soil compaction and organic matter content on percolation.

2. Using the appropriate maps, find out the watershed in which your school is located. Have students use tracing paper to sketch this area. Then take a walking tour of part or all of the watershed. Students should make a list of all the factors that affect the movement of water in that area. Examples could be drainage ditches to control runoff, woodlots that allow more water to percolate into the soil, and street drains to remove precipitation.

Activity Master 16

Matching Land Use with Soils

Quite often we read that a mudslide has damaged homes. Or, that families were evacuated from their homes because of a flood. Or, a group of homes has big cracks in the foundations and walls because the soil subsided. These are all commonplace examples of damage created when the land use practice was not properly matched with the soil type.

Not all soils are suitable for agriculture. Not all soils are suitable for building homes, roads, and factories. Soils have characteristics that may limit their land uses.

For example, some soils are rocky. This makes crop farming difficult. Other soils have a low permeability (they do not let water move through easily) and are poorly drained. Water frequently remains on the surface of such soils for extended periods. Houses should not be built on such soil. Still other soils are sandy and well drained. These soils would make a poor bottom for a pond or reservoir.

The goal of any land use planner, developer, or landowner is to match the use of the land with the soil type. An invaluable reference in helping make such decisions is the soil survey. Published by the Soil Conservation Service, soil surveys exist for the majority of counties in the U.S.

Soil surveys contain aerial photograph maps of the entire county indicating all soil types. In addition, the different soils are described in detail. Charts give agricultural data (expected grain yields in a given soil, etc.); engineering data (suitability of a soil for highway location, etc.); and town and country planning data (suitability of a soil for homesite location, etc.). The local offices of the Soil Conservation Service, soil conservation district, and larger libraries will have copies of county soil surveys.

In this lesson, students view a soils map (Transparency 3) and use soil information provided on the activity sheet to answer questions about land uses.

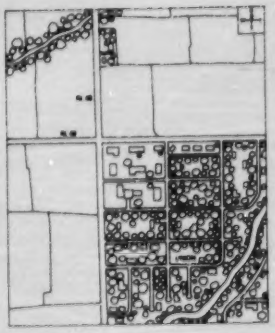
Additional Activity

Arrange for your class to attend a public session of a local planning commission meeting. Or ask someone from the planning commission to talk to your class about the types of local land use options and what is being done to solve them.

Transparency 3

A Soils Map

This transparency illustrates a simplified soils map—it is simplified by making the features larger. The map shows the transition zone between urban and rural environments. Soils that are suitable and unsuitable for agriculture and urban developments are listed and described in Activity Master 16. Students will see examples of both proper and improper land use decisions. This transparency is used with Activity Master 16.



Activity Master 17

Rural Soil Conservation Practices

Soil conservation practices in the rural environment are concerned primarily with controlling erosion in agriculture. However, the urban conservation practices described in Activity Master 18 also apply to roads and building sites in rural areas. The following are four categories of common soil conservation practices that you can see used on farms.

Planting Methods

Soils can be conserved when crop rotation and conservation tillage are used. Crop rotation refers to planting different crops in the same field in future years. For example, a rotation of one year of corn, one year of wheat, and one or two years of hay is used in a field instead of continuous corn. Conservation tillage is the practice of harvesting only the grain from a field and leaving the remaining parts of the plant on the soil. This provides a mulch during the off season and reduces erosion. Next year the new crop is planted through the mulch without plowing under the old plant material.

Drainage Methods

Soils can be conserved by planting and maintaining protective grasses in the normal waterways and shallow ditches that carry runoff water from fields. They safely allow surplus water to run off while minimizing erosion. A second practice involves underground drainage. A grid of porous tile is buried in fields to carry off excess soil water into nearby streams or ditches. Tile drainage permits more water to seep into the soil where it can be carried away. This reduces runoff and standing water problems.

Planting Along the Slope

These practices reduce erosion by slowing the speed of water as it moves down hillsides. Contour planting, a first practice, refers to planting crops parallel to hillsides (along the contour rather than up and down the slope). Strip-cropping, a second practice, involves planting strips or bands of crops with the contour. Strips of close-growing plants, like hay, are planted next to row crops, like corn. A third method is terracing. Terracing involves constructing several embankments or ridges of earth, one above the other, along the contour to control runoff and minimize erosion. From a distance, the terraces look like stairsteps moving up the hill and along the contour. Crops are planted along the terrace.

Planting Windbreaks

Rows of trees or tall grasses are planted at a perpendicular angle to the prevailing winds to reduce wind speed. A slower wind speed reduces the probability of wind erosion. Planting grasses instead of row crops also reduces wind erosion in a field.

In this activity, students read a fact sheet on these soil conservation practices and search for examples of problems and practices in their communities.

Activity Master 18

Urban Soil Conservation Practices

Soil conservation practices in the urban environment are concerned primarily with controlling erosion and runoff water from construction sites. However, the rural conservation practices described in Activity Master 17 also apply in certain urban situations. The following are categories of common soil conservation practices that you can see used in cities.

Erosion Control Methods

The primary goal of these methods is to reduce runoff water and to maintain a cover on top of soil to reduce the erosion potential. This can be accomplished by mulching—securing a layer of straw, burlap, or other material on soil until plants begin to grow. It can also be accomplished with a cover crop of vegetation—usually grasses and other close-growing plants—which holds soil in place and reduces erosion. These practices also reduce wind erosion.

In addition, soil can be stabilized by lining ditches and small waterways with grass, concrete, or asphalt. The banks of larger ditches could also be lined with riprap (irregularly sized and shaped rock material). Contractors often build a small pond to trap silt that runoff washes from construction sites. These sediment basins prevent silt from entering waterways.

Building Along the Slope

In hilly areas, building streets and houses along the contour reduces the potential for erosion and runoff problems. (This type of development uses the same principles that contour planting and terracing do in agricultural fields). Instead of building roads up and down the slope and putting houses on perpendicular secondary streets (traditional grid-type development) this development has roads built on the contour with homes on terraces above and below.

In this activity, students read a fact sheet about these soil conservation practices and search for conservation problems and practices in their communities.

Additional Activities

1. Ask your students to identify ten ideal land use features that they wish their community had (e.g., there should be a small wooded park for every subdivision). Then have small groups select one of the ideal features and outline a plan for implementation. Students should use soil maps and other soil information during their research.

2. If a soil erosion problem exists on school property, have your class develop a reclamation plan for that area. Then, with proper permission from the administration, carry out the plan. You can get help with the planning from your local Soil Conservation Service or conservation district.

Transparency 4

A Land Use Planning Map

This final transparency illustrates a simplified topographic map of an undeveloped area. Kinds of soils are superimposed over hills, a pond, a river, and several wooded areas. Students use this soil map with Activity Masters 17 and 18 to demonstrate their knowledge of soil conservation techniques. The soils are described on Activity Master 16.

Unit III

Critical Soil Issues for the Future

This final unit builds upon the experience your students have gained in soil science and conservation from the previous two units. Students confront current soil issues that will become even more important in the future. At the end of this unit, your students should have a sense of urgency and concern for the issues. But they should also understand that the issues can be resolved with proper and careful management of the soil.

There is only one lesson in this unit, "Six Issues in Soil Conservation." Each activity investigates one critical issue.

Lesson 1

Six Issues in Soil Conservation

This sole lesson in Unit III presents six critical soil issues —issues that affect soils, food supplies, the economy, and the environment. Students analyze the effects of a threatened decrease in soil productivity and the loss of farmland on food production. Then, students examine the issues of wildlife habitat destruction and soil pollution from hazardous chemicals. Finally, students discover the practices of surface mine reclamation and of recycling organic wastes into soils.

Because each activity is self-contained, you can use as many or as few of them as you like, in any order. You may wish to contact the appropriate local officials to determine the status of these issues in your community.

Activity Master 19

Growing Enough Food: Maintaining Soil Productivity

The United States is the world's leading exporter of agricultural goods. Since 1950, the total amount of agricultural goods produced has changed by over 150 percent. At the same time, the number of acres harvested has increased only slightly while the number of farm workers dropped from 12.2 percent to 2.7 percent of the labor force. Technology largely accounted for the increase: better hybrid seed and animal stocks; more powerful machinery; a greater use of agricultural chemicals; and new tillage practices. This technology has resulted in increased yields of crops per acre and greater farm output per hour of labor. This means larger amounts of food can be produced at lower prices. For instance, an average United States family (3.28 persons) spends 17 percent of its annual budget for food. A similar family in Japan spends 25 percent; and in Russia, 50 percent. This use of advanced technology also allows us to export the products of 2 out of every 5 acres harvested.

But this high level of productivity has been attained at a cost. The quality of soils has paid the price with increased levels of soil erosion and decreased amounts of humus. Soils are also experiencing salt and alkaline chemical buildup from irrigation; compaction under the tires of heavy equipment; and possible contamination from acid rain and increased use of agricultural chemicals. (Acid rain occurs when certain exhaust gases from combustion mix with other materials in the air and later fall onto land and water.)

Over the past 50 years, soil productivity has increased because technology has overcome the reduction in soil quality. Can this situation continue into the future? Scientists are divided in their opinions. It is clear, however, that we must maintain our soil productivity in order to grow enough food for ourselves and millions of other people around the world.

In this activity, students draw conclusions from soil quality data presented in several charts.

Activity Master 20

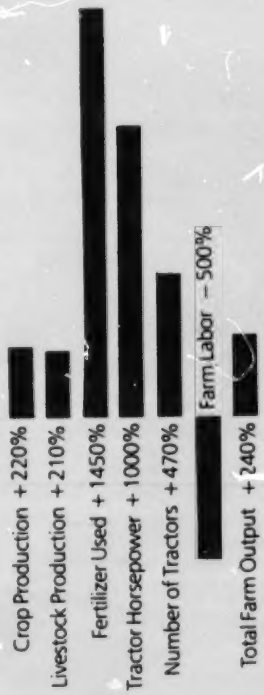
Growing Enough Food: Disappearing Farmland

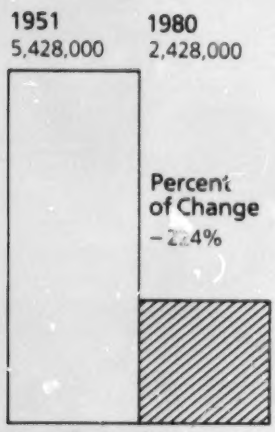
The American farmer produces enough to feed our country and many people in other countries as well. Much of this extraordinary productivity is due to the abundance of well-drained, relatively level, nutrient-rich soils. The United States has more of these rich agricultural soils than perhaps any other country on earth.

But precisely because this farmland is often flat and well drained, it is also perfect for development—development for industrial parks, suburbs, shopping malls, highways, airports, and reservoirs.

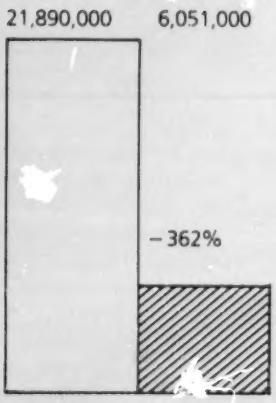
Rural land in this country, some of it our best cropland, is being converted to other uses at an estimated 675,000 acres per year. In the late 1960's and early 1970's when land conversions were at their peak, the annual loss of all types of rural land to various kinds of nonfarm uses ran as high as 7 million acres. Current estimates place the loss at a lower

U.S. Agricultural Productivity 1930-1980





Number of Farms



Farm Population

figure today, since dams, rural airports, highway interchanges, and large housing developments are not being built so rapidly.

Some localities have tried to slow the loss of this valuable resource through zoning. For example, Black Hawk County, Iowa, passed an ordinance that requires thirty-five acres for a single-family dwelling on prime agricultural land, while three acres per site is required on less productive land.

Americans depend on this farmland for their food supplies as do people of many other nations. To meet these needs and to maintain our level of food production, the irreversible loss of farmland must be slowed.

In this activity, students learn how agricultural land is irreversibly lost and why slowing this loss is important.

Additional Activity

Ask your students to make a chart about the geographic history of their family. The chart could list the different locations the family has lived; whether the locations were rural or urban; and what that land is now used for. The chart could be filled out for parents and grandparents. This activity will give your students an appreciation of how land use has changed over time.

Activity Master 21

A Home for Wildlife

When it comes to the basics, wild animals don't differ that much from human beings. In order to survive, they need food, clean water, and shelter.

Unfortunately, the needs of wildlife are often in conflict with human activities as we provide for our own needs and desires. As a result, wildlife habitat in our country is under continuing pressure from development of highways, suburbs, industrial parks, surface mines (although most states now have laws requiring new surface mines to be reclaimed), dams, and reservoirs.

Farms were once an excellent place for wildlife to live. But farmers have changed their planting methods. For instance, many now plant much larger fields and resort to monoculture instead of crop rotation. (Monoculture refers to the practice of planting large areas of a single crop for many years.) These new practices have reduced wildlife habitat on the farm.

Fortunately, many of the techniques used to conserve soil also attract wildlife. For example, grass-lined ditches and waterways as well as grass strips around fields provide habitat for ground-nesting birds. The woody shrubs and trees planted to stabilize gullies are excellent shelter for birds and small mammals. Similar practices can be used in backyards and school grounds.

The goal of any project to restore habitat is to provide a source of food, water, and shelter for many different kinds of wildlife. For specific suggestions for attracting wildlife, refer to the references listed in the resource guide.

In this activity, students learn that food, water, and shelter are important in attracting wildlife. They also conduct a survey to determine the attitudes of people toward preserving wildlife habitat.

Additional Activity

Help your students develop a plan for attracting wildlife into the schoolyard or their backyard. Have them draw a sketch and list the types of things they would do. Try to implement the plan. Several references are listed in the resource guide.

Activity Master 22

Soil Pollution from Hazardous Chemicals

There are over 70,000 chemicals in common use at home and industry and nearly 1,000 new ones are created each year. Not all of these chemicals are hazardous—only the ten percent that are harmful to human health and the environment. Hazardous chemicals are: flammable, explosive, radioactive, corrosive, and toxic. (Toxic hazardous chemicals can alter human genetic material and can become stored in fat tissues.) Some of the common hazardous chemicals are: herbicides and pesticides that are toxic; solvents and liquid fuels that are flammable and explosive; acids and alkalis that are corrosive. We even come into contact with hazardous chemicals daily when we use such products as insect killers, drain cleaners, and certain cleaning agents.

Persistence is a major concern with many hazardous chemicals. Once certain chemicals get into the environment and the soils, those chemicals tend to remain for years. Although some hazardous chemicals break down quickly within a few days, others may last in soils for hundreds, even thousands of years. They can become tightly bonded with soil particles. In addition, natural factors that break down materials—the soil organisms, the sunlight, the atmosphere—have little or no effect. Thus, hazardous chemical pollutants can remain in soils for a long time. Hazardous chemicals that get into agricultural fields can contaminate food and even pollute water supplies if they are eroded from these fields.

Hazardous chemicals can enter the environment and the soils in many ways. Chemicals are sometimes improperly used or illegally dumped. They can also be applied to fields as agricultural chemicals. Since conservation tillage does not necessarily rely upon traditional plowing to control weeds, it requires greater use of herbicides. Hazardous chemicals can also be inadvertently applied to fields in organic (sewage and industrial) sludges. (This will be further investigated in Activity Master 24.) Acid rain is another source of hazardous chemicals. Acid rain falls in many parts of the U.S. where certain exhaust gases and factory emissions from combustion react to make stronger acids of the precipitation.

Ridding ourselves of all hazardous chemicals would not be desirable. Many jobs require their use, and we benefit from the products manufactured

from them. Rather, we must learn to use hazardous chemicals wisely, thereby minimizing the risks of soil and water pollution.

In this activity, students survey their homes for hazardous chemicals and evaluate the safety of several situations.

Activity Master 23

Surface Mining and Reclamation

Usually the terms surface mining (sometimes called strip mining) and reclamation are associated only with coal. But many other mineral resources are also obtained through surface mining, for example: clay, stone, sand and gravel, iron ore, copper, uranium, phosphate, bauxite (aluminum ore), and gold. Each of these minerals is vital for our society. Yet surface mining can be harmful to the land. Heaps of rubble and barren earth can remain. In addition, rivers and streams can become choked with sediment and polluted with acids that drain from the mines.

Over 5.7 million acres of land in the United States have been disrupted by surface mining. This is slightly larger in area than the state of Massachusetts. One-third of this land is located where reclamation is not required by law. This unreclaimed land represents old, worn-out mines that were abandoned before reclamation laws were adopted.

Reclamation involves transforming barren mine areas as nearly as possible to their original condition. Large, earth-moving equipment fills the mined area with rock debris. Machinery molds the soils and shapes the land until it resembles the original contour. Finally, topsoil is spread over the mined area and planted with a mixture of grasses. Often native trees and shrubs are also planted on the reclaimed area.

Improper reclamation can lead to extensive soil erosion and pollution of local water supplies. On the other hand, proper reclamation minimizes these problems and in many cases eliminates them. Most properly reclaimed mines can be used again for productive purposes. One coal-mining company in Ohio has created a very large park with facilities for camping, hiking, and fishing after reclamation. Other productive purposes include farming and growing trees for wood products. Although the costs of reclaiming mines can be high, the benefits to society usually outweigh the costs.

In this activity, students see how proper reclamation is an important part of surface mining.

Activity Master 24

Recycling Organic Wastes

Problem: Today, many of our agricultural soils have less organic matter than they did in the past. Organic matter is a valuable soil ingredient that provides food for soil plants and animals. It also allows water to percolate into soil more easily.

Problem: Reclaiming surface mines can be difficult if the soil lacks organic matter. These soils erode more readily and it is more difficult for plants to grow.

Problem: The amount of organic wastes from municipal sewage treatment plants keeps increasing. Food processors produce organic waste in large amounts. Currently, most of this waste is buried in landfills.

A solution for all three of these problems is to recycle the organic wastes by applying them on agricultural fields and reclaimed surface mines. This practice helps build up the soil and disposes of a waste product. However, some of these wastes—especially those from municipal-industrial sewage treatment plants—can contain contaminants. They can be polluted with heavy metals such as mercury, lead, and cadmium which come from local industries. Other pollutants can be hazardous chemicals, such as solvents and fire retardants. These pollutants are hazardous to human health, since plants grown in soils contaminated with heavy metals and hazardous chemicals can absorb these substances and introduce them into the food chain.

A solution to the contamination hazard is to carefully test all wastes before they are applied to fields. Once the contamination problem is successfully controlled, and once application methods and rates are perfected, recycling of organic wastes will benefit society. Not only will the wastes be safely disposed of, but soils will be more productive as well.

In this activity, students will investigate costs and benefits of recycling organic wastes.

Additional Activity

List the six issues in soil conservation on the board, then divide your class into small groups. Have each group rank order the six issues from the most important to solve to the least important to solve. Each group can then present its ordered list and summarize its justification to the class. Then have a consensus vote after the presentations.

Resource Guide

This final section of *Conserving Soil* consists of: 1) a bibliography of the materials used in the writing of this educational package; and 2) a list of additional sources of information from which you can easily obtain further environmental and soils materials.

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Additional Sources of Information

Educational Resources Information Center (ERIC)

ERIC is a national information retrieval system for education resources on a variety of topics. The documents are on microfiche in hundreds of university libraries throughout the U.S. Thousands of environmental education documents are on microfiche and specific titles are available for a modest fee from:

ERIC, Science, Mathematics, and Environmental Education
The Ohio State University
1200 Chambers Rd., Room 310
Columbus, Ohio 43212

Soil Conservation Service (SCS)

The SCS helps landowners conserve the soil and water resources of the U.S. The SCS has published environmental education materials on soil and water conservation. Contact your local SCS office, or write:

Educational Relations
USDA Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

Soil Conservation Society of America (SCSA)

The SCSA has a variety of environmental education materials concerning many aspects of conservation. Contact them for a publications list:

Soil Conservation Society of America
7515 Northwest Ankeny Road
Ankeny, Iowa 50021

Departments of Natural Resources

In most states, the Department of Natural Resources (or equivalent agency) publishes materials on such topics as how to attract wildlife into your backyard. They may also have other environmental publications of interest to teachers. Contact the Education, Public Information, or Publications office of your state Department of Natural Resources.

Other Local Sources

The following are some other places near your school where you can find information on the local environmental situation:

The telephone book. Look under local, state, and federal government; trade associations; and corporate public relations offices.

The daily newspaper.

Local colleges or universities. Contact appropriate departments and visit libraries.

Parents of students. Also consider your colleagues in other disciplines.

The local library. Look for these periodicals: *Environment, National Wildlife,* and *Audubon* as well as a list of local conservation organizations.

(Note: You may want to photocopy the glossary on pages 17 & 18 for your students at the beginning of the unit.)

Soils Glossary

Acid Rain–Rain, snow, or other forms of water that are made more acid by waste gases which come mainly from the burning of coal and oil products. The gases (usually sulfur dioxide and oxides of nitrogen) mix with water and other materials in the air. Acid rain falls on the land and water and can affect wildlife, plants, soil, and building materials.

Acre–A unit of measurement of land. It is equal to the area of land inside a square that is about 209 feet on each side (43,560 square feet).

Algae–Microscopic green plants that live in water and on land. They serve as food for other organisms.

Bacteria–Microscopic organisms that live on water and on land. They help break down organic materials into simpler nutrients in a process called decay. Bacteria release nutrients to the soil.

Bedrock–A more or less solid layer of rock found on the surface of the land or below the soil.

Cell Division–The process by which a plant or animal cell splits in half to form younger cells.

Commodity–A useful or valuable product of agriculture such as soybeans, beets, or cattle.

Composting–Mixing decaying organic matter (food scraps, grass clippings, leaves) to form a rich soil conditioner.

Condensation–Changing a gas into a liquid; for example, when steam or water vapor turn into water.

Elongation–The process in which something becomes longer, such as plant cells as they grow.

Evaporation–Changing a liquid to a gas; for example, when water turns into steam or water vapor.

Export–A product (such as grain or meat) that is traded with another nation.

Famine–An extreme shortage of food in a given area.

Feedlot–An enclosed area in which animals, such as hogs or cattle, are fed before being sold for meat.

Fungi (plural of fungus)–A group of non-green plants, such as molds, and mushrooms, that live on dead or dying organic matter. Fungi release nutrients to the soil.

Goods–An item or thing, such as bread, meat, or fruit, that people are willing to buy.

Habitat–An area of land in which plants and animals live, grow, and reproduce.

Humus–Highly decomposed plant and animal residue that is a part of soil.

Hydrologic Cycle–The cycle of water movement from the atmosphere to the earth and back again through these steps: evaporation, transpiration, condensation, precipitation, percolation, runoff, and storage.

Irreversible–A situation that is impossible to change. For example, it is impossible to change a shopping mall back to farmland.

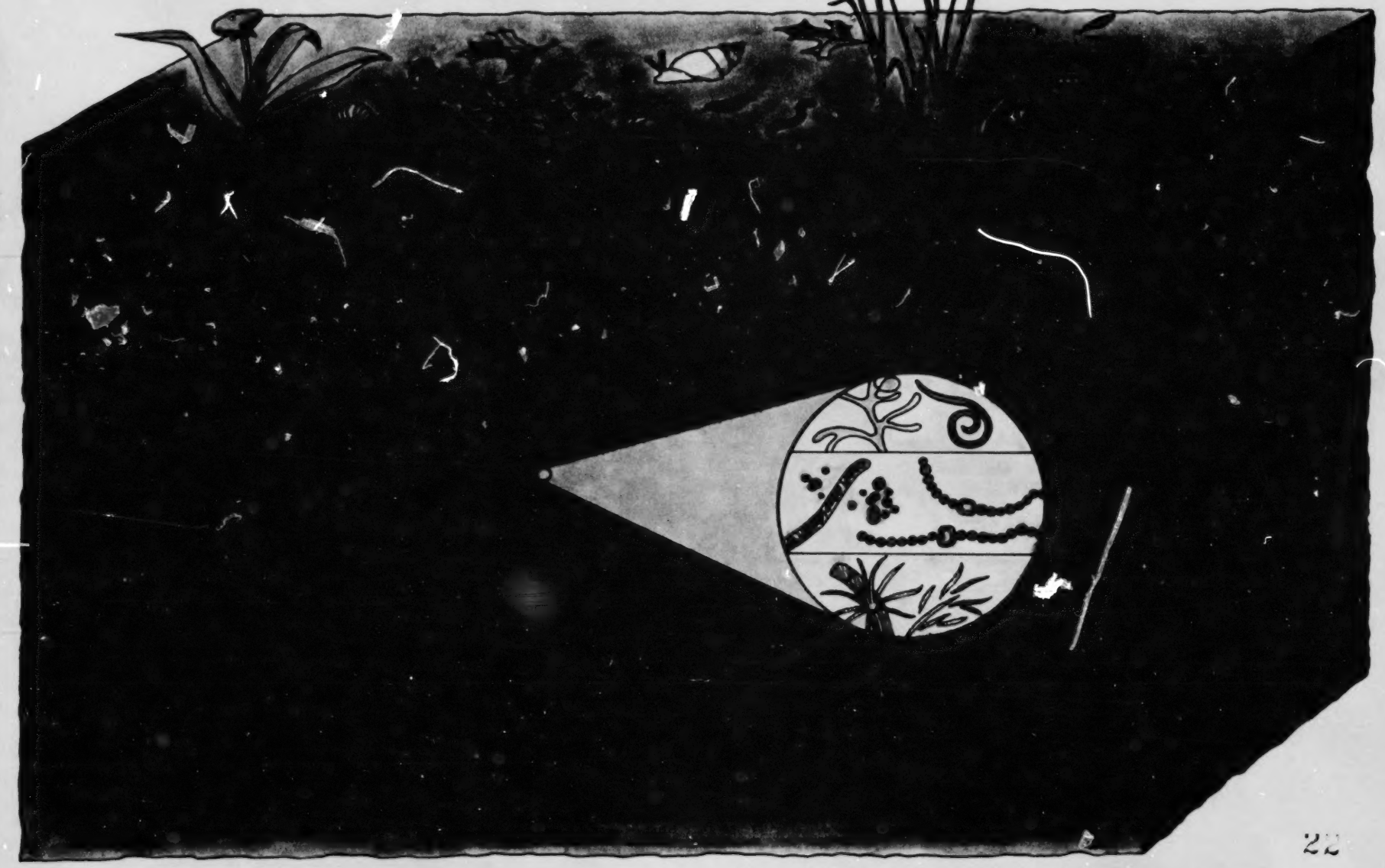
Land–One of the major factors of production that is supplied by nature and includes all natural resources in their original state such as mineral deposits, wildlife, timber, fish, water, and the fertility of the soil.

Landfill–A location where solid waste (garbage) is disposed of.

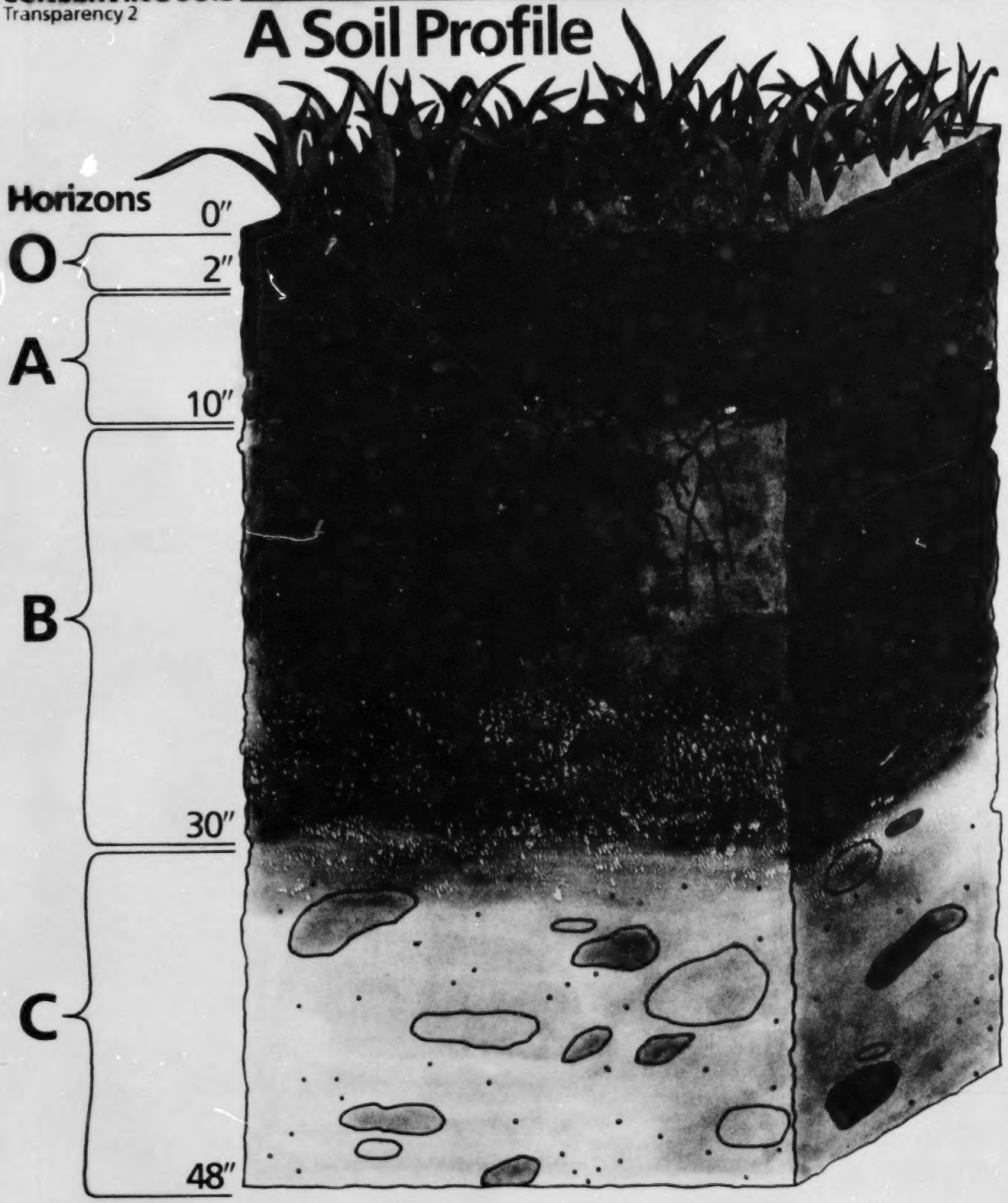
Leaching–The removal of soluble minerals from soil by the downward movement of water.

Mineral–A naturally occurring inorganic substance with definite chemical and physical properties and a definite crystal structure.
Monoculture–The cultivation of a single type of crop over a large area which excludes other uses of that land.
Native Americans–The people who lived in the United States before it was inhabited by people from Europe, Asia, and other continents.
Nematodes–Microscopic, elongated worms that live on other organisms in the soil.
Nutrient–A substance that supplies nourishment for an organism to live. It can be food or chemicals depending upon the organism.
Nutrient Exchange–The process by which plant roots exchange an acid for nutrients from the soil.
Organic Matter–Plant and animal material in various stages of decomposition that may be part of the soil.
Parent Material–The earthy materials—both mineral and organic—from which soil is formed.
Percolation–The downward movement of water in soil.
Permeability–The quality of soil that allows air or water to move through it.
Photosynthesis–The process in which green plants combine water and carbon dioxide gas in the presence of light to form sugars and oxygen gas.
Plains States–The area of the United States that is generally west of the Mississippi River and east of the Rocky Mountains (also called the Great Plains).
Pore Spaces–The area of the soil through which water and air move. The space between soil particles.
Precipitation–Rain, snow, and other forms of water that fall to earth.
Productivity–The amount of crops or animals that can be harvested from land. It can also mean the general amount of goods made in a given time or in a given area.
Respiration–The process by which organisms obtain energy when sugars combine with oxygen. Carbon dioxide and water are given off.
Row Crops–Agricultural crops, such as corn and soybeans, that are grown in rows.
Runoff–Water that flows off land into streams and other waterways.
Soil–A naturally occurring mixture of minerals, organic matter, water, and air which has a definite structure and composition and forms on the surface of the land.
Soil Color–The color of a sample of soil.
Soil Horizon–A layer of soil that is nearly parallel to the land surface and is different from layers above and below.
Soil Mineral–That portion of the soil that is inorganic and neither air nor water.
Soil Survey–The identification, classification, mapping, interpretation, and explanation of the soil over a given area of land.
Soil Texture–The relative amounts of sand, silt, and clay in a given soil sample.
Technology–The many different methods used to provide goods for human needs and wants.
Water Storage–The locations in which water is stored. They can be above ground in lakes, rivers, and other waterways or below ground as ground water.
Zone of Accumulation–The layers in a soil into which soluble compounds are moved and deposited by water.
Zone of Decomposition–Surface layers in a soil in which organic matter decays.
Zone of Leaching–The layers in a soil from which soluble nutrients are removed by water.

A Soil Ecosystem

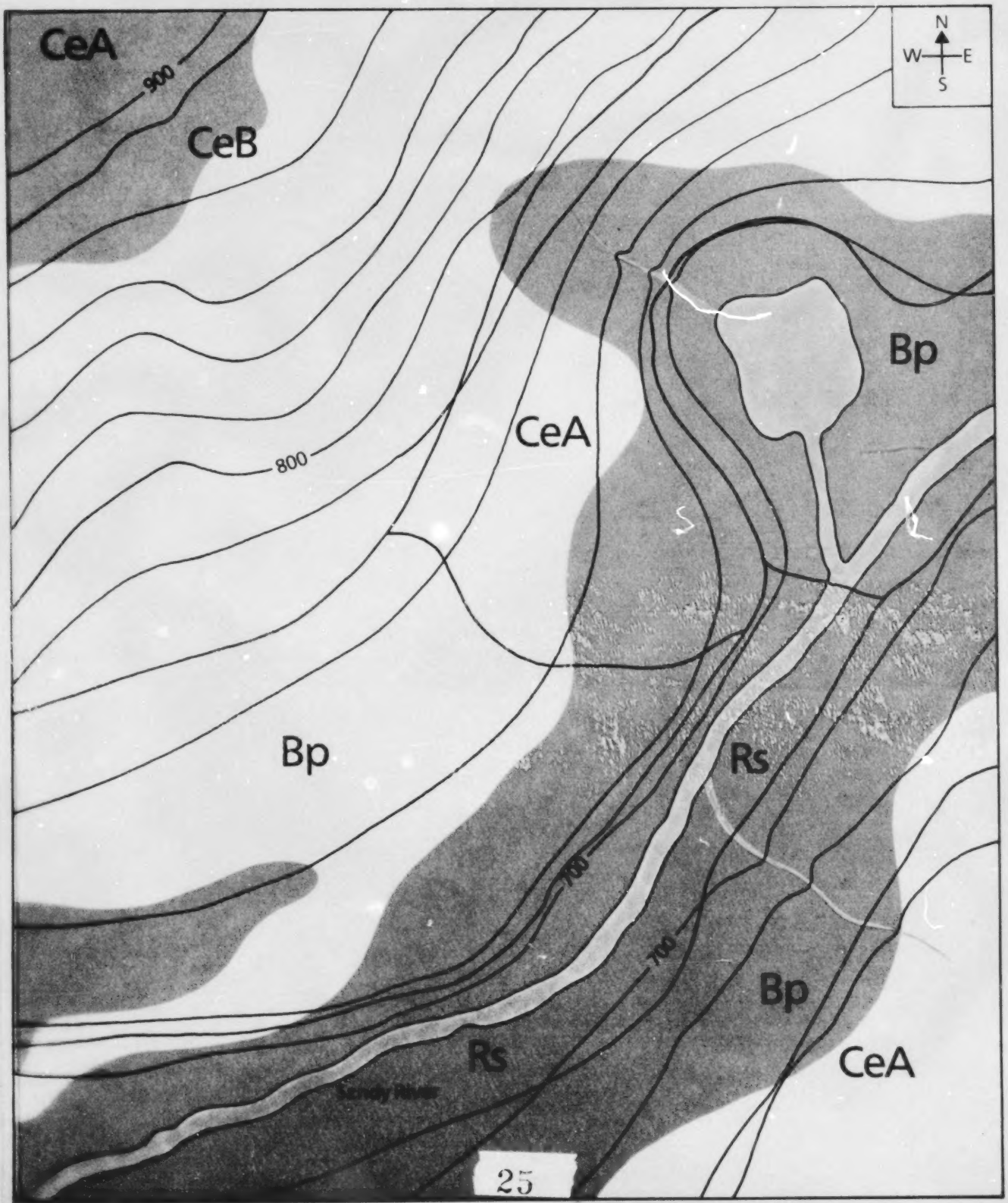


A Soil Profile



A Soil Map

A Land Use Planning Map



Activity Master 1

Soils: What Are They?

Objectives

1. Students will identify the major components of a soil sample.
2. Students will examine a soil for texture.
3. Students will analyze the physical differences among several samples of topsoil.

Supplies Needed: magnifying glasses, microscopes, a sieve, soil samples

Explain that in this activity, students will be investigating soils. Determine your students' level of understanding of soils by asking them to write the word that first comes to their mind when they hear the word "soil." Write several of the words on the board. Later explain that a soil is a naturally occurring mixture of mineral and organic materials with a specific structure and composition that develops on the surface of the land.

State that the best way to understand soil is to get really close to it and to examine it. Ask students to collect soils from many different locations. Have them volunteer to sample the top two inches of soil from a flower pot, a backyard, a school yard, an agricultural field, a woodlot, a forest, near a creek, etc. (You can collect samples from locations where you feel your students should not go, such as near a river or a cliff.) Students can bring them to school in a jar or in a plastic bag. When your students collect the sample, they should answer the questions in Part 1 and label their samples (i.e., location, date, weather, etc.).

When your students have brought in soil samples, conduct Part 2. Describe the major ingredients of soils and list the types of minerals and the particle size on the board. Students should use magnifying glasses, microscopes, or sieves of different screen size to examine their soil samples.

To conclude this first activity, ask students to examine at least three different samples and then record on the back of the activity sheet the information requested.

Students should save the soil samples for use in Activity 5.

Soils: What Are They?

Part 1

Have you ever stopped and looked at the soil that is all around you? It's down below your feet and easy to ignore. There are billions of small plants and animals in soil and you are walking on top of their homes. When you stand in a field of grass, you could be on top of a city of ants. There could even be a family of moles beneath your feet.

Look at the soil that is all around you. Get a trowel or shovel. Dig up enough of the top two inches of the soil to fill a pint or a quart jar. Look closely at the particles and living creatures that make up the soil.

Describe the place where you collected your soil sample. _____

_____

Describe your soil. What color is it? _____

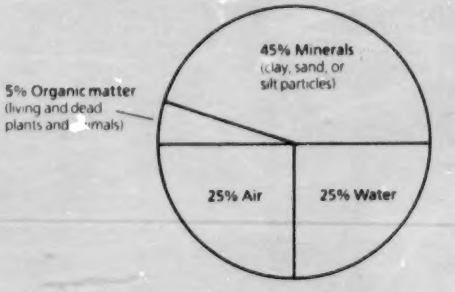
What does it smell like? _____

What does it feel like? _____

Do you see any living plants or animals? What do they look like? _____

Part 2

Soils are mixtures of four ingredients. The amount of each ingredient changes from one soil to another. This pie diagram shows the average amount of each.



Look at your soil sample. The mineral particles give the soil texture. Separate some of the larger minerals and look closely at them with a magnifying glass or microscope. Ask your teacher to help you identify them as either sand, silt, or clay. On the other side of this sheet, draw pictures of the organic matter and minerals that you see. Describe the organic matter in your soil sample.

_____

What do the mineral ingredients look like?

_____

Why does the amount of water in the soil change? _____

_____

Where are the air and water found in the soil?

_____

Part 3

Trade your soil sample with several of your classmates. On the back of this activity sheet write the name of the person and the location from which the sample was taken. Then describe how the sample is different from or similar to yours. Examine the color, smell, texture, and organic matter.

Activity Master 2

Soil Ecology: Plants and Animals Under Your Feet

Objectives

1. Students will label a diagram of a root.
2. Students will describe the process of nutrient exchange.
3. Students will examine soil samples for living organisms.
4. Students will investigate the role of living organisms in the soil.

Supplies Needed: white trays, tweezers, magnifying glasses, specimen bottles, muslin, seeds, soil samples

A few days before this lesson, place ten seeds of different types of plants (corn or beans) on muslin. Roll up the muslin, loosely tie, and saturate it. Keep it warm and moist for several days. At the beginning of this activity, unroll it and have students look at root hairs with a microscope or magnifying glass. Discuss with your students the processes that occur in the three regions of the root. Ask for volunteers to fill in the blank statements in Part 1, and later label the parts of a root in Part 2.

In Part 3, students search for living animal organisms in soil samples. Obtain three or four samples from the top few inches of several very different soils. Students will work in small groups so several quart jars of each sample will be needed.

Project Transparency 1—The Soil Ecosystem—and ask students to pick out examples of the six types of animals listed on the activity sheet.

Divide the class into small groups and present each group with a soil sample. Show them how to carefully sort through soil samples to find animals. Sort the soil on white paper or in a light-colored pan. Have several reference books handy so that students can also name the type of animals they find and determine the function of the organism in the soil ecosystem. (Several good reference books on identification of plants and animals are listed in the resource guide in the back of the program.)

Soil Ecology: Plants and Animals Under Your Feet

Part 1

Fill in the blanks in these statements using the words below. Words are used only once.

The **root cap** protects the growing root. Behind the cap, cells quickly **divide** to form new root cells. Soon these new cells grow longer, or **elongate**. As the cells divide and elongate, the roots **grow** through a soil. Growing roots create strong pressures which can even split rocks.

As roots live and grow they undergo **respiration**. In this process, roots take in oxygen from the **pore spaces**. They also give off **carbon dioxide** which reacts with water to form a weak **acid**. The root releases part of the acid. In return the root hairs absorb **nutrients** from the soil particles. Nutrients include magnesium, calcium, potassium, phosphorus, and **nitrogen**. The process is called **nutrient exchange**.

During this exchange plants get needed nutrients. The soil picks up an acid that breaks down soil particles or **minerals** into simpler nutrients. Most of the nutrients are absorbed in the plant through the **root hairs**. They also absorb **water** from the soil.

acid	nutrient exchange
carbon dioxide	nutrients
divide	pore spaces
elongate	respiration
grow	root cap
minerals	root hairs
nitrogen	water

Part 2

Plants absorb water and nutrients from the soil through their roots. The roots also help break down minerals in the soil. Match the parts in the illustration with the parts of a root listed below. Place the correct letter in the space beside each word or phrase.

f region of absorption
d dividing root cells
h region of cell division
c elongating root cells
g region of elongation
e root cap
a root hairs
b sand

Part 3

Place your sample in a white tray or on white paper. Use a magnifying glass to carefully look through a sample of soil. Pick out all the living animal organisms with tweezers. Place them into small bottles that are labeled according to these groups.

1. worms without legs (earthworm for example)
2. grubs (thick, worm-like animals usually with legs)
3. snails and slugs (snails without shells)
4. insects (animals with six legs)
5. spiders (animals with eight legs)
6. other animals

Then examine and try to identify each organism.

Activity Master 3

How Is a Soil Formed?

Objectives

1. Students will explain how parent material, climate, living organisms, topography, and time are related to soil formation.
2. Students will describe why different types of parent material produce different kinds of soils.

Supplies needed: samples of several types of parent material, plastic container with tightly fitting lid, soil, ant farm

Parent Material

Have your students collect samples of rock and other parent material from outcroppings at construction sites or road cuts. Using reference materials, students can identify the material. (Several books on rock identification are listed in the resource guide.) A local college, university, museum of natural history,or Soil Conservation Service office could identify the parent material in your area.

Climate

There are two simple experiments that quickly show the effects of climate on weathering. Have your students describe the impact of these experiments on parent material on the back of the activity sheet.

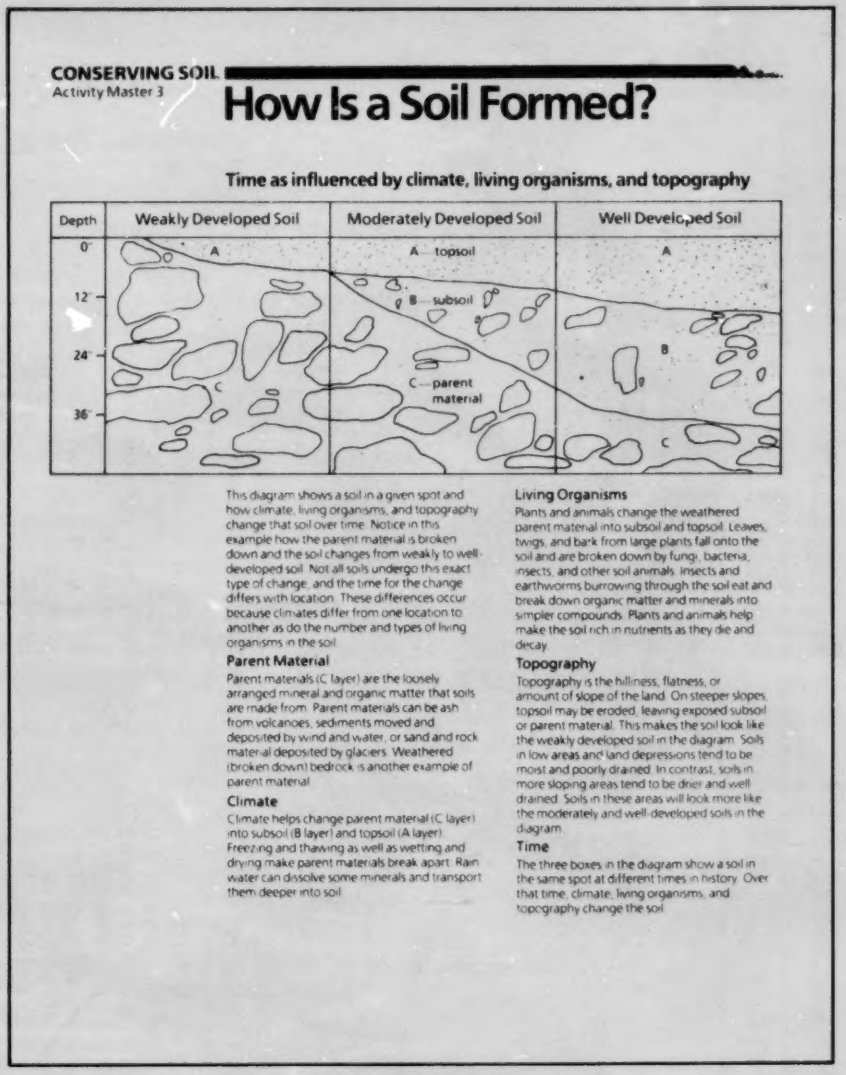
1. *Freezing and Thawing*—Fill a plastic container with water and freeze it. The expanding water will cause the sides to bulge out, or will lift the lid. This same process occurs when water freezes in the cracks of rock and pavement.

2. *Wetting and Drying*—Take a handful of moist soil; squeeze it to make a firm ball. Place the ball in water. Usually it will fall apart. Pour off water and let soil dry. Compare the shape and looks of the soil when wet and when dry.

Living Organisms

Set up an ant farm in the classroom. Students will quickly see how the ants alter the soil structure and redistribute the organic matter. Students can also search for evidence of how animals alter the soil outdoors (i.e., tracks, holes, diggings, etc.).

You may want to ask your students these questions: (1) Why do organic gardeners sometimes put earthworms in their gardens? (They help keep the soil loose.) (2) Why is it important to have a lot of organic matter in soils? (It's a source of nutrients. It makes soil fertile. It allows water and air to enter the soil more easily).



CONSERVING SOIL
Activity Master 3

How Is a Soil Formed?

Time as influenced by climate, living organisms, and topography

This diagram shows a soil in a given spot and how climate, living organisms, and topography change that soil over time. Notice in this example how the parent material is broken down and the soil changes from weakly to well-developed soil. Not all soils undergo this exact type of change, and the time for the change differs with location. These differences occur because climates differ from one location to another as do the number and types of living organisms in the soil.

Parent Material

Parent materials (C layer) are the loosely arranged mineral and organic matter that soils are made from. Parent materials can be ash from volcanoes, sediments moved and deposited by wind and water, or sand and rock material deposited by glaciers. Weathered (broken down) bedrock is another example of parent material.

Climate

Climate helps change parent material (C layer) into subsoil (B layer) and topsoil (A layer). Freezing and thawing as well as wetting and drying make parent materials break apart. Rain water can dissolve some minerals and transport them deeper into soil.

Living Organisms

Plants and animals change the weathered parent material into subsoil and topsoil. Leaves, twigs, and bark from large plants fall onto the soil and are broken down by fungi, bacteria, insects, and other soil animals. Insects and earthworms burrowing through the soil eat and break down organic matter and minerals into simpler compounds. Plants and animals help make the soil rich in nutrients as they die and decay.

Topography

Topography is the hilliness, flatness, or amount of slope of the land. On steeper slopes, topsoil may be eroded, leaving exposed subsoil or parent material. This makes the soil look like the weakly developed soil in the diagram. Soils in low areas and land depressions tend to be moist and poorly drained. In contrast, soils in more sloping areas tend to be drier and well drained. Soils in these areas will look more like the moderately and well-developed soils in the diagram.

Time

The three boxes in the diagram show a soil in the same spot at different times in history. Over that time, climate, living organisms, and topography change the soil.

Topography

Ask students to collect soil samples for organic matter from the top of a hill, from a slope, and from the bottom of a deep valley. Compare the samples for moisture and organic matter content.

Time

Use the diagram from the activity sheet to reinforce the evolution of soil from parent material.

Activity Master 4

What Are Soil Horizons?

Objectives

1. Students will inspect and diagram exposed soil profiles that are found near their homes.
2. Students will tell why soils form horizons.

Supplies Needed: soil samples, bean seeds, containers for growing beans

Project Transparency 2, A Soil Profile, and explain to your students that this is a hypothetical example. Then use the transparency and the information outlined in the teacher's guide to help your students fill out the chart on the top of the activity sheet. For the second part of the activity, students should observe a soil profile and record their observations. List areas in your community (i.e., building sites, road cuts, etc.) where students can find a soil profile. Tell your students to be careful in these areas.

If your school property is large enough and you have permission, you might consider digging a soil pit. Soil pits are holes in the ground that are dug about 4 feet deep and 4 feet in diameter. The A and B horizons are usually evident within that depth.

After your students have observed the horizons, ask them to list how their example differed from the hypothetical one on the transparency. Then they could speculate why their example differed from the illustration. Possible answers include: Erosion or a bulldozer could have removed much of the topsoil. There could be very little surface organic matter because the land had been plowed and the organic matter was mixed into the A horizon. You could obtain samples of soils from the A and B horizons of a profile and have students answer the questions from the samples. You should provide them with the depth measurements that are asked for in the activity.

To conclude this lesson, plant two bean seeds (or similar fast-growing seeds) in pots containing soil from the A and B horizons. Always add the same amount of water and keep them under similar lighting conditions. Daily for the next 3 to 4 weeks, students should measure and record the heights on graph paper, using a different symbol for the plant in each soil. Students should compare the growth differences on the charts and discuss the possible reasons for them.

What Are Soil Horizons?

Older, undisturbed soils form into layers called horizons. Soil horizons can usually be seen at a road cut. They can also be seen where the soil is exposed several feet deep. There are four horizons on most older, undisturbed soils.

With the help of your teacher, fill in this chart about soil horizons.

Horizon	Name	Colors	Structure	Processes Occurring
O	Organic	Black, dark brown	Loose, crumbly, well broken up	Decomposition
A	Topsoil	Dark brown to yellow	Generally loose, crumbly, well broken up	Zone of leaching
B	Subsoil	Brown, red, yellow, or gray	Generally larger chunks, may be dense or crumbly, can be cement-like	Zone of accumulation
C	Parent material (slightly weathered material)	Variable—depending on parent material	Loose to dense	Weathering, disintegration of parent material or rock

Hunt for a good example of a soil profile. Look for an area where you can see the O, A, and B horizons. Road cuts are good areas. Carefully look at the profile, measure the depth of the layers from the surface.

Answer these questions while observing the soil horizon. Then on the back of this sheet draw a sketch of the soil profile about to scale. Label the horizons and indicate depths below the surface and any organisms that you see.

O Horizon

About how thick is the layer? _____

What color is it? _____ What types of material can you see in this O horizon? _____

Describe the structure _____

Describe evidence of plants or animals _____

A Horizon

How thick is this layer? The top is _____ inches below the surface and the bottom is _____ inches below the surface. What color is it? _____ Describe the structure _____

Describe evidence of plants or animals _____

B Horizon

How thick is it? The top is _____ inches below the surface and the bottom of the B horizon is _____ inches below the surface.

What is the color? _____ Describe the structure _____

Describe evidence of plants or animals _____

Activity Master 5

How Do Soils Differ?

Objectives

1. Students will collect soil samples from near their homes.
2. Students will analyze and compare the different soil samples.
3. Students will describe why and how soils differ.

Supplies Needed: metric scales, graduated beaker, soil samples, quart jar

Soil samples from Activity 1 can be used for this experiment. Students should work in small groups to analyze their soil samples and to answer the questions.

This simple experiment allows you to separate soils into layers of different-sized particles. Put a cup of soil into a quart jar and fill it with water. Replace the lid and shake the soil mixture vigorously and let the soil particles settle. You will have to let the jar sit for several hours to several days to let all particles settle. The coarser materials will be on the bottom and the finer materials on top. Materials will settle out in this order from bottom to top: coarse sand, fine sand, silt, and clay with organic matter mixed and floating on top. Clay particles are very small and take a long time to settle.

Separate several different soils by this method and have students diagram and label the layers.

Your students can also estimate the volume of pore space in a soil sample. Have them measure 100 milliliters (ml) of a soil sample into a glass or beaker. Determine the mass of the sample and beaker and record data. Slowly pour water into the sample until the water level rises to the top of the soil sample. Then redetermine the mass of the mixture. The mass difference in grams is equal to the volume of pore space in milliliters per 100 ml of soil since 1 gram of water = 1 ml of water. Have students compare the pore space volume of several soil samples. Discuss the importance of pore space with your class.

CONSERVING SOIL
Activity Master 5

How Do Soils Differ?

Soils differ from one another in many ways. One soil can be acid. Another can be low in nutrients. These soils have chemical differences. The easiest way to tell one soil from another is to look at physical traits. Two important physical traits are color and texture.

Use the following charts and answer the questions below about your soil sample.

Soil Type by Color	Organic Content	Fertility	Aeration
Dark Soils: Dark gray, black, brown	High	High	High
Moderately Dark Soils: Brown to yellow-brown	Medium	Medium	Medium
Light-Colored Soils: Pale brown to yellow or red	Low	Low	Low

Soil Type by Texture	Feel When Wet	Looseness of Soil	Water-Holding Capacity	Aeration
Clayey	Very sticky, smooth, slick	Poor	High (water is held so tightly that less is available for plants)	Low
Sandy	Very gritty	Good, loose, crumbly	Poor	High
Loamy	Smooth and slick, somewhat gritty and sticky	Good, loose, crumbly	Good to excellent	High

What is the color of your soil sample? _____

What is the texture of your soil sample? _____

Would you buy a farm with this type of soil on most of the fields? _____ Why? _____

Why are pore spaces so important in soils? _____

Why is it important for soil to have good drainage? _____

Describe the perfect physical traits of soil for a garden or an agricultural field. Color: Dark: black, brown, dark gray

Texture: Loamy.

Activity Master 6

We Depend Upon Soils

Objectives

1. Students will describe some of the different steps involved in producing common consumer goods.
2. Students will identify soil as a natural resource common to all consumer products.

Supplies Needed: reference material

A few days before this activity, contact your school librarian for some reference materials that your students will need to complete this activity. Most of the information will be available from almanacs, encyclopedias, maps, product labels, and personal knowledge.

After the students have individually completed the first section of the activity, have volunteers read their answers to the class.

Next, divide your students into small groups to research one of the pizza ingredients. Also ask the group to add at least one of their favorite ingredients to the list. Each group should present their findings to the class so that others can fill in the chart at the bottom of the activity sheet.

Conclude the activity by pointing out that every product that we buy, the energy we use, and the foods we eat are directly or indirectly a product of soils. More complicated items, such as an automobile, require more resources. Thus, more soils in different locations are involved.

We Depend Upon Soils

Where Do Our Consumer Products Come From?

This is a list of items that we often use. Using encyclopedias and other references, try to match the resources with each item. Most items need more than one resource. And each resource may be used more than once.

Items

Lightbulb – tungsten, iron, copper
Telephone – copper, iron, oil, rubber
Soft drink can – aluminum, iron
Electric power – coal, oil
Record album – oil
Jeans – cotton, iron, oil
Automobile – iron, aluminum, copper, chromium, rubber
Winter jacket – wool, cotton, oil, iron

Resources

oil	aluminum
copper	wool
coal	rubber
tungsten	chromium
iron	cotton

Either the land, soil, or water could have been listed as a resource for each item. Why? _____

Where Did Our Pizza Come From?

Listed below are some of the ingredients of a pizza. You may want to add some of your favorites that are not on the list. Look up
1. the resource material of the ingredient.
2. a possible geographic location of the resource material.
3. what processing step(s) are needed to make the ingredient.
4. a possible geographic location of the processing.

Then fill in this chart. The first item has been done as an example.

Ingredient	Resource Material	Location	Processing	Location
Flour	Wheat	Kansas	cleaning, milling	Indianapolis, Indiana
Salt				
Spices				
Tomato Sauce				
Sausage				
Pepperoni				
Your favorites!				
_____				
_____				

The ingredients came from many different locations and were processed in many others. What basic natural resources are common to the pizza ingredients?
Soil, land, water, sunlight

Activity Master 7

How People Have Used Soils

Objectives

1. Students will discover the relationship of early Native Americans to the environment, the land, and the soils.
2. Students will describe ways that modern technology can alter the land and the soils in beneficial and detrimental ways.
3. Students will state why we should carefully examine our land use decisions before we act on them.

Supplies Needed: reference materials

Part 1

Have your students read the first part of the activity sheet, then ask them to brainstorm sources of information to answer the questions. List their answers on the board. Possible sources include: Native Americans still living in the area, school and public libraries, state and local historical societies, museums of natural history, anthropology departments of local colleges, and the local conservation district or Soil Conservation Service offices.

You could divide the class into small groups and have each group answer the five questions using a different source of information. Help students determine the best method of gathering the information from outside sources; for example, a telephone interview or a letter. Later, compare each group's answers.

Part 2

Several sources of information for these questions are listed in the resource guide. The answers will be based upon opinions since the terms helpful and harmful are relative and vary in meaning from one person to another. Furthermore, there is no correct answer to question 3. It should stimulate your students to think critically about how we use the land and apply technology.

CONSERVING SOIL
Activity Master 7

How People Have Used Soils

Part 1

We have always needed food, water, and materials to build shelter. The land and its soils have always provided these resources. This was especially true with the early Native Americans.

Native Americans were closely related to the land. They could not farm large areas or dig large mines. The Native Americans were greatly affected by the climate, the soils, and the vegetation. For instance, only a few of the Native Americans in the Plains States established farming villages. In many areas of the Plains States the climate and soils made farming difficult. These Native Americans could not grow enough food like those living in the Southwest and the Ohio Valley. Most moved from place to place living in temporary camps and following their primary food source — the buffalo. These Native Americans kept moving their camps with the herds.

Find out what Native Americans lived in your area many years ago. Read about them and find the answer to these questions.

1. What Native Americans lived in your area?
2. What types of food did they use?
3. How did they get food, water, and shelter?
4. Did they live in villages or travel from place to place?
5. Could they farm large areas for food?

Part 2

Today we still rely upon the land and its soils. It provides us with many natural resources. But we can change large areas of land with our advanced technology and machines. Most of us are not as close to the land as the Native Americans were. Instead we use machines to alter the land to get food, water, and material for shelter. In the process, we have both helped and harmed the land.

Using encyclopedias and your own experience, answer the following questions.

1. List some of the ways our use of technology has harmed the land.
2. List some of the ways our use of technology has helped the land.
3. Many scientists say that we should use less technology. A bad decision could harm the land for many years. Other scientists say that we depend upon the use of technology to supply the goods we need and want. We should use more technology. Which group do you think is correct? Why?

Activity Master 8

U.S. History Was Affected by Soils

Objectives

1. Students will conduct research to list the reasons Americans continually moved west during the Colonial Period and the first one hundred years of our nation's history.
2. Students will evaluate the critical role that land in general and soils in particular had in this westward migration.
3. Students will contrast this historical perspective with our current dependence upon the soils.

Supplies Needed: research materials

Several days before the activity, contact your school librarian to obtain reference material on the topics. This will help your students get started. (A list of references appears in the resource guide.)

Since your students will be working in small groups on a report, a key to this activity is organization. You may want to present this action plan to your students to help them organize.

1. Select one of the questions for research.
2. Conduct preliminary research on the topic.
3. Create an outline.
4. Determine what information you need to complete the outline.
5. Conduct research.
6. Decide how to present the information.
7. Select visual aids that can be used to help your presentation.

Divide the class into small groups and discuss the interrelationships that exist among the land, soils, water, plants, animals, and minerals. Then ask your students to read the activity master, have them select or assign a topic to each group, and have them get started. Let your students know whether the end result should be an oral or written report, or a more creative expression such as a skit, play, or newscast. Also set a deadline for the presentation.

CONSERVING SOIL
Activity Master 8

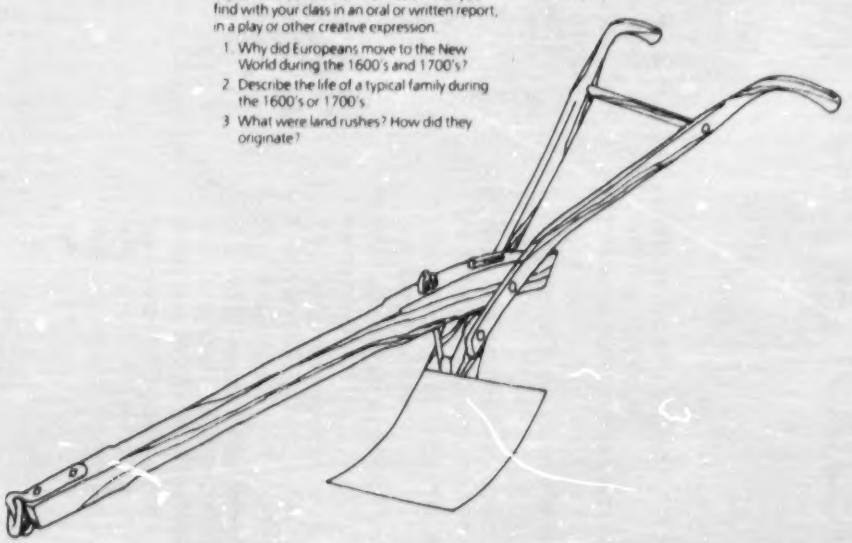
U.S. History Was Affected by Soils

The land is the surface of the earth and all its natural resources: the plants, the animals, minerals, and, more important, the soils. The United States is a nation blessed with large areas of fertile soils. It was called a land of abundance by early explorers and settlers. They came from Europe in the 1600's and 1700's. When they arrived they found large forests for timber. They found many animals for their fur pelts. The soils were the source of this great abundance.

The land and the soil were also very important from 1820 to 1900. At that time the U.S. was rapidly growing westward. Most Americans felt that they had the right to move westward into the Louisiana Purchase, California, and the Oregon Territory. The western soils were fertile. The land was free or inexpensive. As pioneers moved west, the nation became larger.

Below are a list of questions about these two periods of U.S. history. Get together in small groups with your classmates. Research the topics. Later, share the information that you find with your class in an oral or written report, in a play or other creative expression.

1. Why did Europeans move to the New World during the 1600's and 1700's?
2. Describe the life of a typical family during the 1600's or 1700's.
3. What were land rushes? How did they originate?
4. What was the Homestead Act of 1862? Why was it important?
5. Why did pioneers move into the Great Plains?
6. Describe the life of a pioneer family during the 1850's.
7. What is the history of inventions such as the steel plow, barbed wire, and windmills?
8. What difficulties did railroads have in the westward expansion?
9. What advantages did railroads bring to the western pioneers?
10. Describe farming practices during the 1700's and 1850's, and compare them with modern practices.
11. How did this westward movement affect the Native Americans, their agricultural practices, and their use of the land?
12. How did minority groups influence the settlement of the United States? What has been their impact on American agriculture?



Activity Master 9

How We Degrade Soils

Objectives

1. Students will recognize why human activity tends to degrade soils.
2. Students will state how human activity degrades soils.
3. Students will explain why soil degradation is a serious problem.

Supplies Needed: reference materials

Ask your students to work individually to match the problems with the facts. In some cases they will need resource materials. The following are brief comments upon the correct answers that you will probably want to mention to your students.

1. Land with factories and homes built on it cannot be changed back into cropland. The cost would be too great.
2. The hazardous waste dump sites can add poisons to soils that may not break down for hundreds or even thousands of years. These same poisons may pollute water supplies.
3. Fewer crops are harvested from severely eroded soils. Silt that runs off can cause water pollution. These soils are more easily eroded in the future.
4. Soils can become compacted under the heavy weight of tractor tires. Compacted soils are not as productive and they erode more quickly than non-compacted soils. Proper conservation methods do overcome these problems, however.

5 and 6. The land cannot be used again for agriculture until it is properly reclaimed. Water pollution can result and erosion can be high since soils are exposed.

7. Water pollution can result from water that runs off the feedlots. If the feedlot is on soil, it will erode more rapidly.
8. Pesticides used to protect young seedlings can get into runoff water and cause water pollution. Erosion can occur until the trees are large enough to protect the soil.
9. Paving the land for shopping centers, houses, or transportation permanently takes the land away from agriculture. Paving also speeds runoff during rainfall or snowmelt.

CONSERVING SOIL
Activity Master 9

How We Degrade Soils

The following two lists concern the loss of soil quality. The first contains ten facts about soils. The second lists the problems that could occur if soils degrade. The problems are related to the facts. Match the problem with the related fact. Then place the letter or letters of the problem in the space beside each fact.

The Facts

A 1. Each year 675,000 acres of American cropland are changed into other uses. This is equal to a one-third mile strip of land stretching from New York to California.

A,B,D 2. Scientists have found over 6,000 dumps with leaking barrels of hazardous wastes. More findings are expected.

C,D,E 3. Up to 22 tons of topsoil are eroded each year from an acre of land in certain regions of the country. This is about 11 pickup truckloads of soil from an area the size of a football field.

E 4. Farmers now use larger machines for planting and harvesting their crops. As a result one farm worker now supplies food and fiber for 78 people.

A,C,D,E 5. Nearly 3 billion tons of minerals are mined each year. The minerals are made into steel, glass, and many other items.

A,C,D,E 6. Each U.S. citizen throws away about 4 pounds of trash every day. This trash is usually buried in a landfill.

D,E 7. Over 150 million livestock are sold each year for food. Many of these animals spend part of their lives in feedlots.

D,E 8. Nearly $1 billion of forest products are sold each year. The amount sold per year is expected to double in the next 40 years.

A,E 9. There is about one car for every 2 people living in the U.S. Many square miles of soil have been paved to make room for these cars.

The Problems

A. The land for practical purposes can never again be used for agriculture.
B. The amount of chemicals can build up and remain in the soils for many years.
C. The soil can grow fewer crops.
D. Nearby or distant water supplies can become polluted.
E. The soils could erode more rapidly.

Activity Master 10

Soil Erosion: How It Occurs, Part 1

Objectives

1. Students will identify local examples of sheet, rill, and gully erosion.
2. Students will discuss how sheet, rill, and gully erosion occur.
3. Students will list why sheet, rill, and gully erosion occur.

Supplies Needed: stream table (commercial or homemade)

Ask students to brainstorm reasons why erosion is a serious economic factor. List the reasons on the board. Students should realize that soil erosion is serious and has an impact on all of us. Obvious impacts would be the cost of dredging silt from rivers and harbors. This would increase taxes. In addition, food costs could rise since eroded soils are less productive.

Emphasize the fact that 6.4 billion tons of soils are eroded from U.S. land each year. This amount of soil would fill 320 million average-size dump trucks if each truck carried 20 tons of soil. If these trucks were parked end-to-end and were 25 feet long, they would extend to the moon and three-quarters of the way back.

Describe the three types of erosion caused by moving water and have your students fill in the chart. Then ask your students to search for examples of erosion in their community and answer the remaining questions. If this is not possible, you could take photographs using slide film and project the slides in class. You could also search for examples on the school grounds.

You can demonstrate the types of erosion in the classroom in a commercially purchased stream table. (If you do not have access to a stream table, you can make one out of a shallow, rigid box lined with waterproof plastic. Fill the box with sand.)

Sprinkle water down the sloped stream table. Controlling the amount of water and the slope by trial and error, all three types of erosion can be demonstrated. Demonstrate the effect of slope and vegetation on erosion.

Soil Erosion: How It Occurs, Part 1

Erosion occurs when the soil is moved from one place to another by moving water or wind. Three types of erosion are caused by moving water: sheet, rill, and gully erosion. Your teacher will describe the differences between the types. Use that information to fill in this chart.

Type of Erosion	Description	Causes
Sheet		
Rill		
Gully		

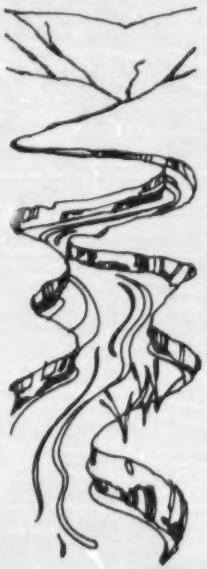
Look through your community for examples of these types of soil erosion. When you find them, photograph or draw pictures of them. Then answer these questions.

Sheet Erosion

Where did you see sheet erosion? _____

How did you know sheet erosion had occurred? _____

Why did sheet erosion occur in this area? _____



Rill Erosion

Where did you see rill erosion? _____

How did you know that rill erosion had occurred? _____

Why did rill erosion occur in this area? _____

Gully Erosion

Where did you see gully erosion? _____

How did you know that gully erosion had occurred? _____

Why did gully erosion occur in this area? _____

Activity Master 11

Soil Erosion: How It Occurs, Part 2

Objectives

1. Students identify local examples of land slippage and wind erosion.
2. Students will list why land slippage and wind erosion occur.
3. Students will rank the erosion problems in their community.

Supplies Needed: none

Students should be able to answer the true-or-false questions on wind erosion and land slippage from information gained from previous activities. Otherwise you could ask for volunteers for answers and cover one question at a time. Explain to your students why each question is true or false.

Next your students can search for examples of wind erosion and land slippage. Wind erosion can be difficult to see. Evidence includes very small dunes of silt and sand around rocks, trees, and other obstructions to the wind. They somewhat resemble snow drifts but are much smaller. Another clue is gritty dust on window sills in your house. Land slippage is more common along river-banks and steep road embankments.

As the final activity, review the five types of erosion. Then have your students rank them from the largest to the smallest for your area. The problems may vary within your community. To obtain rankings, they can interview local farmers or the city manager. Or they can use personal observations. To determine the actual ranking of soil erosion in your location, contact your local Soil Conservation Service or conservation district office.

Soil Erosion: How It Occurs, Part 2

In Activity 10 you learned how moving water causes sheet, rill, and gully erosion. Soil is also moved from one location to another by the wind and by land slippage. Wind erosion is a greater factor in the Plains States, but it can be seen anywhere strong winds move across bare soil.

Answer these true or false questions to learn more about wind erosion. Place a T on the line if the question is true, or an F if the question is false.

___F___ 1. Wind erosion is worse in forests and in the mountains.
___T___ 2. Soils that are covered with many trees and other plants erode less often than uncovered soils.
___T___ 3. Wind erosion is more likely to occur at high wind speeds.
___F___ 4. Wind erosion is greatly affected by the amount of rainfall: the greater the rain, the greater the loss.
___T___ 5. Some soils are more easily eroded by wind than others.

Write the answers to these two questions on the back of this activity sheet. 1. Where have you noticed wind erosion in your community? 2. How did you know it was wind erosion?

Soils are also eroded by land slippage. Land slippage occurs when large blocks of soil move downhill. Answer these questions to find out more about land slippage.

___F___ 1. Moving soil with a bulldozer to fill in a gully is an example of land slippage.
___T___ 2. California has many mudslides during the rainy seasons. They damage homes and roads. These mudslides are examples of land slippage.
___T___ 3. Land slippage can often be seen along steep road cuts.
___T___ 4. Frequent freezing and thawing can also cause soil to move down hills. This can be seen on farm fields during the winter.
___F___ 5. Land slippage damages more land than any other type of soil erosion.

Describe any land slippage problems that occur in your community on the other side of this activity sheet. Tell why and where it occurred.

Sheet, rill, gully, and wind erosion as well as land slippage are five types of soil erosion. In the space below, place the five types of erosion in order. Begin with the largest problem in your area. End with the smallest problem in your area.

Largest problem _____	_____ Location of problem
_____	_____
_____	_____
_____	_____
Smallest problem _____	_____

Activity Master 12

Soil Erosion: How It Affects Us

Objectives

1. Students will conduct research on the Dust Bowl era.
2. Students will compose short stories about the impact of the Dust Bowl on the individual.

Supplies Needed: research materials

Begin by asking students to read the first paragraph of the activity sheet. Then have them brainstorm other ways that soil erosion affects us. List the answers on the board. Students should conclude that there are no benefits to soil erosion.

Next your students should read the remaining part of the activity sheet. You can add any other information to emphasize the tragedy of the Dust Bowl. You could also read all or portions of the first chapter of John Steinbeck's *The Grapes of Wrath*. This short chapter includes a realistic description of what the dust storms looked like. It also has a brief section on how the storms affected farmers.

To conclude the lesson, ask your students to conduct any research that they need to write a short story or other creative expression. Students could read books about the Dust Bowl era or read articles in magazines from that time. (Most large libraries keep back issues of periodicals in storage.) Students could also interview persons who lived then. Contact your local Soil Conservation Service for information on how the Dust Bowl could have been prevented. The short stories or other forms of creative expression should be written as if the student lived through the Dust Bowl.

You might also invite a person that lived during the Dust Bowl era to speak to your class. Or, as an alternative, tape record an interview with that person. Such an experience would be an excellent culmination to this activity.

Soil Erosion: How It Affects Us

Soil erosion is an expensive national problem. Each of us pays for it in higher food bills and higher taxes. Eroded soils can not grow as much food per acre. Silt and sediment must be dug more often from our harbors and rivers to clear the way for boat and ship traffic.

The Dust Bowl era is the best example of how erosion can affect people. The Dust Bowl occurred during the 1930's in Texas, Kansas, Oklahoma, New Mexico, and Colorado. Drought and harsh winds created large dust storms. Eroded soil filled the skies. The sun looked blood-red through the gray haze. Farm equipment, houses, and roads were buried. Soil was blown so high into the air that it traveled as far away as Washington, D.C.

Read these facts about the Dust Bowl era.

1. The nation was in the Great Depression. Jobs were scarce and money was in short supply.
2. Tough prairie grasses were replaced with less drought-resistant crops of corn and wheat.
3. Many acres of rangeland were overgrazed and were left bare or with little cover crop.
4. A series of severe droughts occurred in 1931, '34, '36, and '37.
5. Millions of acres of corn and wheat withered and died in the Plains because of the drought.
6. Farmers could not make payments on loans. Many lost their homes and farms to banks and loan companies.
7. Huge dust storms eroded the soils. In some places from two inches to one foot of topsoil were lost.
8. Thousands of unemployed, poor farm families left the Dust Bowl area. Many of them headed for California. They often became migratory workers living in camps.
9. There was a sense of gloom, confusion, misery, and hopelessness among the many people who lived in the Dust Bowl.
10. The Dust Bowl was caused by a combination of three factors: the Great Depression, drought, and poor agricultural practices.

How would you have felt living in the Dust Bowl era? Would your family have left? Where would you have gone? What would you have done?

Think about these questions, then write a short story or other creative expression about the Dust Bowl. It need not be long, just a few paragraphs will do. If you need help, use one of these sentences to get you started.

"Christmas of 1937 would have made Mr. Scrooge happy. . ."

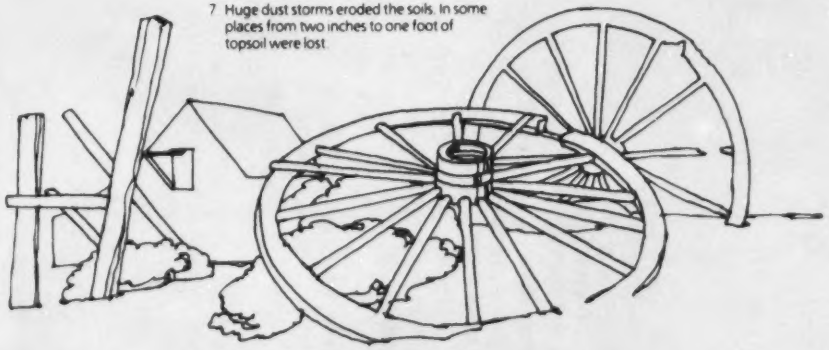
"The porch swing banged behind me as I tried to escape the terrible heat of the long afternoon."

"As a rural mail carrier I hated the letters I had to deliver from banks to small farmers."

"No one answered my question: Would we have to leave Rex behind?"

"Pa kicked at the dry stubble — all that was left of a promising spring crop."

"We could have prevented the Dust Bowl if only we had. . ."



Activity Master 13

Why Conserve Soils?

Objectives

1. Students will tell why soils can be called one of our most valuable resources.
2. Students will categorize reasons for conserving soils as humanitarian, economic, stewardship, environmental, or aesthetic.

Supplies Needed: none

The 15 words at the bottom of the page are hidden in the word puzzle and are used to fill in the blanks of the statements. Each of these statements is a reason we should conserve soils.

List the five categories of soil conservation reasons on the board and explain their meaning to your students. Then have your students categorize each of 15 statements on the activity sheet. Students can place the following abbreviations on the space before each statement: HUM for humanitarian reasons; ECON for economic; STEW for stewardship; ENV for environmental; and AES for aesthetic. It is possible that one reason may fit into more than one category. Ask your students to brainstorm other examples for each of the categories. Conclude this activity by asking the question, "Why can soils be called one of our most valuable natural resources?" Clearly all of the reasons listed on the activity sheet and those brainstormed by your students answer the question.

CONSERVING SOIL
Activity Master 13

Why Conserve Soils?

There are 15 words hidden in this puzzle. These words are listed below. Try to find as many as you can. You can circle them across, down, and diagonally. The letters of each word are always in order. Then use the letter of the correct word to fill in the blank in these statements.

N	O	N	B	F	A	R	M	L	A	N	D	Q	F	A	P
E	A	U	Z	U	A	R	P	O	I	M	F	E	K	I	B
X	H	T	G	T	D	P	O	L	L	U	T	I	O	N	E
C	L	R	U	U	J	S	C	E	N	E	R	Y	C	N	X
O	M	I	N	R	O	O	E	U	T	D	J	F	I	P	P
N	K	T	Z	E	A	I	V	G	A	H	R	M	Q	C	O
S	B	I	G	D	W	L	I	X	Q	G	A	I	R	I	R
E	X	O	L	H	Y	E	R	P	R	F	O	O	D	I	T
R	E	N	D	U	M	R	K	E	Y	U	S	Y	T	S	W
V	P	A	O	N	H	O	Z	F	S	R	K	P	B	A	N
A	Y	L	T	G	O	S	U	Q	Z	O	B	G	M	E	S
T	X	G	T	R	X	I	X	L	A	C	U	G	L	Y	H
I	O	U	A	Y	L	O	Q	N	B	V	Z	R	E	W	C
O	V	P	E	Q	F	N	V	N	F	B	O	M	C	I	N
N	W	F	W	I	L	D	L	I	F	E	J	S	K	E	L
P	P	R	O	D	U	C	T	I	V	I	T	Y	C	M	S

___ 1. Soils are one of our most valuable ___h___.
___ 2. Severe soil erosion can lead to water ___j___.
___ 3. Soil ___k___ must be kept high to produce all of the food we need.
___ 4. People in many developing nations would be ___g___ without food aid from the U.S.
___ 5. Prosperous, productive farms provide us with beautiful ___l___ as we travel along our nation's highways.
___ 6. Windbreaks and other soil conservation practices create homes for birds, rabbits, foxes, and other kinds of ___o___.
___ 7. The ___f___ depends upon productive soils.
___ 8. U.S. food aid helps meet the ___i___ needs of many people in developing nations.
___ 9. More than 40 years after the Dust Bowl era, ___m___ is still a national challenge.
___10. Soil erosion can increase the price of the ___e___ that we eat.
___11. Mudslides, gullies, and muddy water are ___n___ to look at.
___12. Soil ___a___ is an important part of prosperous farming.
___13. ___c___ occurs when there are severe food shortages in an area.
___14. Every day, more and more ___d___ is lost to non-agricultural use.
___15. Food is a major ___b___ that we sell to nations around the world.

a. conservation
b. export
c. famine
d. farmland
e. food
f. future
g. hungry
h. natural resources
i. nutritional
j. pollution
k. productivity
l. scenery
m. soil erosion
n. ugly
o. wildlife

Activity Master 14

Managing Soil Resources

Objectives

1. Students will investigate the history of the Soil Conservation Service (SCS) and soil conservation districts.
2. Students will locate their local SCS and soil conservation district offices.
3. Students will describe the services offered by their local SCS and soil conservation district offices.

Supplies Needed: research material

Begin this activity by asking your students to read the top of the activity sheet. You may decide to add any additional information from the guide or other resources as a supplement. Students could also further research the topic of soil conservation in a library. They could focus on former national figures such as Hugh Hammond Bennett, the first Chief of SCS, or Louis Bromfield, a prominent writer, conservationist, and farmer. They could look under these subject headings for appropriate topics: Conservation, Natural Resources, Soil Conservation, or Soil Erosion.

If a local individual or group (such as youth groups, the League of Women Voters, or the Audubon Society) has a significant role in conservation, students could report on their activities. Local libraries and historical societies are good sources of this information.

Students should first use their home telephone directory to find the offices of the local SCS office (listed under U.S. Government, U.S. Department of Agriculture) and the conservation district (listed under State or County Government). Next you could contact the offices and obtain needed information for the class. Otherwise the offices may be overrun with calls. It may be helpful to ask a conservationist from these offices to speak to your classes. Students should write a list of questions to ask the speakers. Such a resource person would be an asset for this and the remaining activities of this lesson.

Managing Soil Resources

During the Dust Bowl era, many people became very worried about soil erosion. As a result, three cooperating agencies were created. They help Americans conserve soils. All three are still working together to help us use soil resources wisely.

The Soil Conservation Service (SCS) was formed in 1935. It is part of the U.S. Department of Agriculture. This agency has offices in almost every county in the U.S. Its headquarters are in Washington, D.C. The SCS conducts soil surveys. It also researches conservation methods and shows citizens how to use soil properly. An important job is to give land owners information to help them conserve soil and water.

Another USDA agency, the Agricultural Stabilization and Conservation Service (ASCS), provides cost-sharing to land users for conservation work.

A third unit is the soil conservation district. Conservation districts are located in almost every county. They are a branch of the local government. In 1937 President Franklin Roosevelt asked the states to pass laws permitting conservation districts to organize.

A group of people who are either elected or appointed are in charge of the district. They set local conservation priorities.

With the help of your teacher, answer the following questions about these two agencies.

Soil Conservation Service

Under what listing in the telephone book would you find this agency?

_____

What is the telephone number and address of your local SCS office? _____

_____

What recent projects has your local SCS office worked on? _____

_____

How can your local SCS office help the landowner? _____

_____

Soil Conservation District

Under what listing in the telephone book would you find this agency? _____

_____

What is the telephone number and address of your local office? _____

_____

What recent projects has your local office worked on? _____

_____

How can your local office help the landowner? _____

_____

Activity Master 15

Managing Water Resources

Objectives

1. Students will define a watershed.
2. Students will sketch the watershed of a stream.
3. Students will describe the hydrologic cycle.
4. Students will summarize the importance of properly managing soils and surface water runoff to minimize erosion and water pollution.

Supplies Needed: U.S. Geologic Survey topographic map or road map of your community, tracing paper

Students will need to know the definition of a watershed and the basic principles of the hydrologic cycle for this activity. Begin by providing this information to your class. Then describe how to outline a watershed on a map. This can be done by drawing a line around a waterway along the crests of the highest ridgetops. On a 7½-minute-scale U.S. Geologic Survey topographic map, this can be done using the elevation contour lines. On a road map or on the activity master, draw a line roughly equidistant between adjacent waterways. Have your students do this for a local stream, using tracing paper and maps.

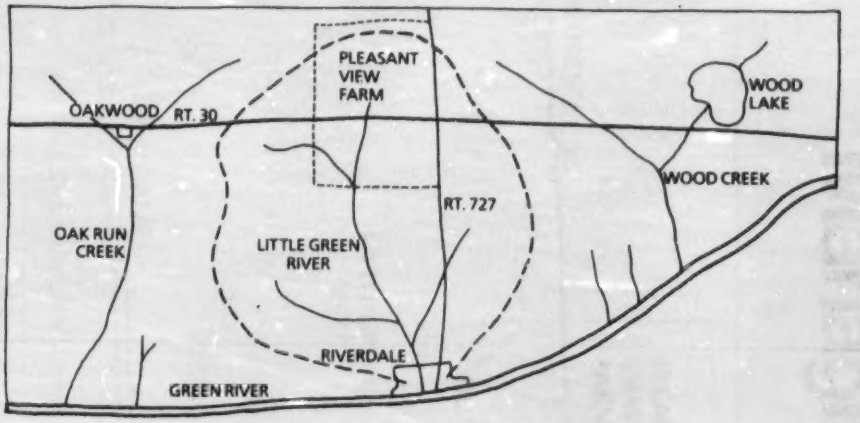
Help students draw the watershed for the Little Green River on the activity master. Then answer the questions as a class exercise. Have students read each question, then ask for volunteers to answer them.

The following are possible answers:

1. All the land area that drains into a particular stream or stream system.
2. See dashed line on map.
3. Brown and full of silt.
4. None. They are in different watersheds.
5. Soil Conservation Service and the local soil conservation district.
6. Upstream along the Little Green River, and within its watershed.
7. It could cause more silt to enter the Little Green River. It could also cause more frequent flooding since water could run off the fields faster.
8. Dark, rich, and full of organic matter and living organisms.
9. Soil and water management practices affect the movement of water within the watershed, not between watersheds.

CONSERVING SOIL
Activity Master 15

Managing Soil Resources



1. Define the term "watershed." _____
2. Outline the Little Green River watershed. *(Shown as dashed line.)*
3. The person that owns Pleasant View Farm practices poor soil conservation. Describe the water that flows through Riverdale after a heavy rain. _____
4. What effect would poor soil conservation on Pleasant View Farm have on Wood Creek? _____
   Why? _____
5. The citizens of Riverdale are angry because the Little Green River floods every spring. It is also brown with silt after every rain. What local government agencies can help them? _____
6. Suppose you are a soil conservationist. Where would you look for the source of Riverdale's water problems? _____
7. Suppose the person that owned Pleasant View Farm allows cattle to overgraze the fields. The pastures are almost bare. What effect(s) would this have on the Little Green River? _____
8. Describe an ideal type of soil to prevent runoff and soil erosion for the owner of Pleasant View Farm. _____
9. Why is the watershed an important unit of land to study in soil and water conservation? _____

Activity Master 16

Matching Land Use with Soils

Objectives

1. Students will examine a simplified soil map and observe soil types.
2. Students will search for examples of problems that were created because land use was not properly matched with soil types.
3. Students will evaluate a land use suggestion,given soil types on a simplified soil map.

Supplies Needed: colored transparency markers

Describe for your students examples of problems that can result from not matching land use with the proper soils. Ask your students to search for similar examples in the newspaper or in their community.

Project Transparency 3, A Soils Map. Point out the cardinal points on the map. Also point out the town and buildings, rivers, and other land features on the map. The soil types are shown in red. Once your students are accustomed to reading the soil map, have them work on Activity Master 16.

Emphasize that soils are a limiting factor in using the land. Obtain a soil survey for your county. Show it to the class and describe its use. Have students search for their homes on the map.

Possible answers include:

1. Celina-A and Celina-B
2. Brookston and Ross
3. No. Because it is subject to frequent flooding.
4. Brookston and Ross
5. Farming or a park or play area
6. Homes in the southern part of Union are built on the Ross and Brookston soils,which have severe limitations for homesite location.
7. Celina-A and Celina-B. Brookston and Ross if buildings are placed on higher ground.

Conclude the lesson by stating that Union wants to expand west into the land across route 48. People want new homes, stores, and a park.

Ask a volunteer to shade the areas on the transparency where they would put homes and shops (on the Celina-B soil). Then have a volunteer draw parallel lines on the transparency where they would put the park (on the Brookston soil).

Note: The chart from this activity sheet will be needed for Activities 17 and 18.

CONSERVING SOIL
Activity Master 16

Matching Land Use with Soils

Look closely at the soils map on Transparency 3. It is an illustration from an aerial photograph. The soil types are outlined in red.

This chart is a summary of information about the soils found on this map. It is taken from a soil survey. The chart lists the types of limitations that are placed on land use by soils. (Seasonally high water usually occurs in winter and early spring.)

Use this information to answer questions about the soil map.

1. Which soils are the best for building homes, stores, and roads? _____
2. Which soils are the worst for building homes, stores, and roads? _____
3. Should any home or factory construction take place on a Ross soil? _____ Why? _____
4. On what kinds of soil would you expect to see large pools of water after rains? _____
5. What type(s) of land use would you recommend on a Brookston (Bp) soil? _____
6. What evidence of poor land use can you see in the town of Union? _____
7. On what soils would you recommend building a park or play area? _____

Soil	Description	Farming	Homesite Location	Construc-tion of Streets	Parks and Play Areas
Brookston (Bp)	Very dark grayish brown, poorly drained	Severe: seasonally high water	Severe: seasonally high water	Severe: seasonally high water	Moderate: seasonally high water
Celina-A (CeA)	Brown to dark brown, runoff is slow	Slight	Slight	Slight	Slight
Celina-B (CeB)	Brown to dark brown, runoff is medium fast	Slight	Moderate: subject to erosion	Moderate: subject to erosion	Moderate: subject to erosion
Ross (Rs)	Very dark grayish brown, well drained, sandy in places	Severe: frequent flooding	Severe: frequent flooding	Severe: frequent flooding	Severe: frequent flooding

Activity Master 17

Rural Soil Conservation Practices

Objectives

1. Students will describe soil conservation practices that are common in the rural environment. (Many of these soil conserving methods also work well in cities or suburbs.)
2. Students will investigate their communities for soil conservation practices.
3. Students will recommend a conservation practice for problem areas that they find.
4. Students will recommend conservation practices for the areas illustrated in Transparency 4.

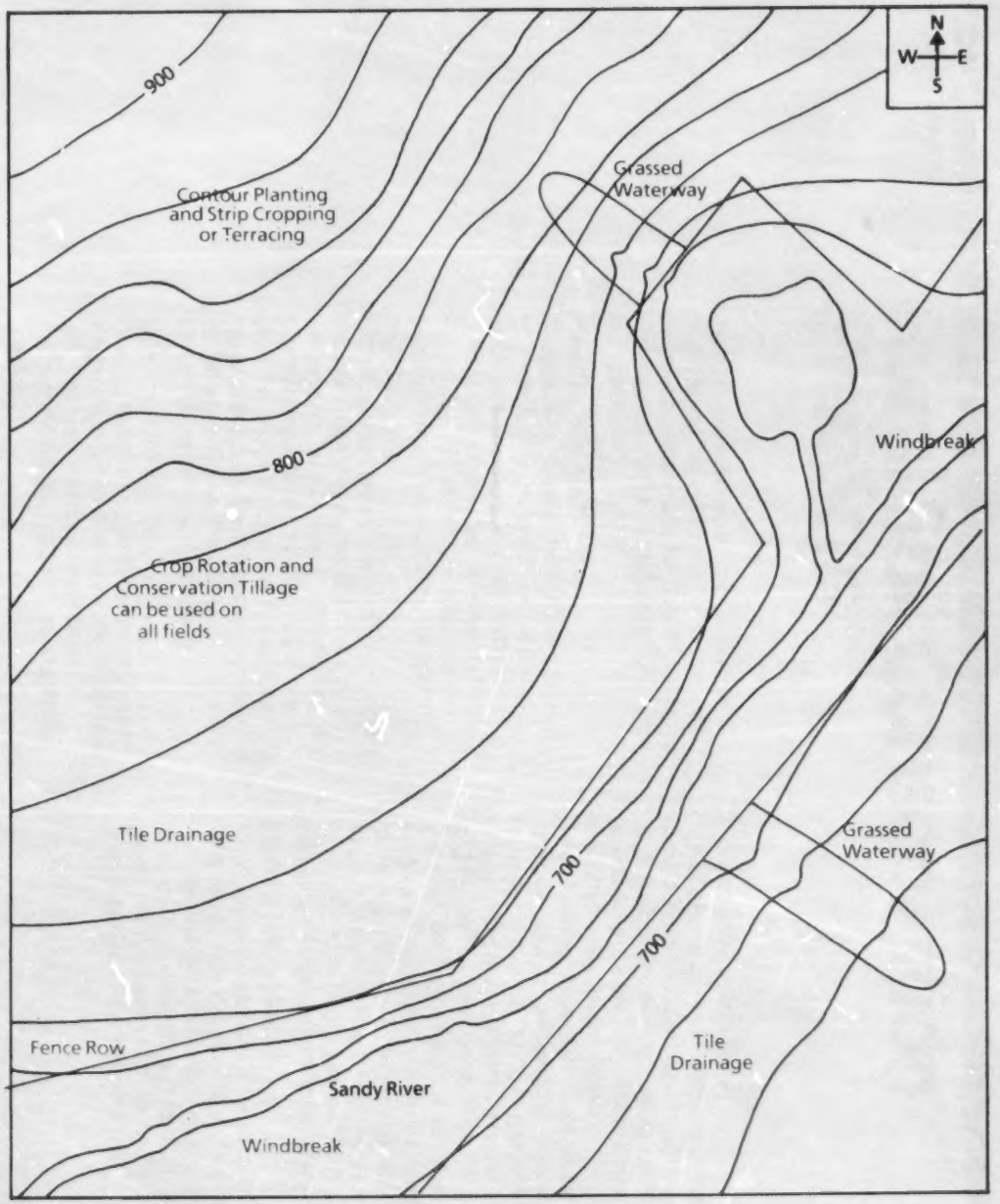
Supplies Needed: different color transparency markers

After students have read the activity sheet, review the rural soil conservation practices. Then project Transparency 4. It is a simplified topographic map of an undeveloped area with soil types (described in Activity Master 16) superimposed over the land features.

Explain to your students how to read the map. Point out the elevation contour lines, soil types, and other land features. State that this is a map of a farm. Ask students to give suggestions of conservation practices that can be used in the different areas of the farm. They should refer to the soil chart in Activity 16 and the fact sheet in Activity 17 to make their land use decisions.

First ask your students to help you outline the agricultural fields. Use a dark-colored marker to outline the fields on the transparency. Begin with conservation tillage, the first method listed on the fact sheet. Have your students suggest areas on the map where this type of tillage can be used to conserve soil. Write the name of the conservation practice on the transparency. Continue down the list of eight practices on the fact sheet. Ask your students to suggest areas on the map where the remaining conservation methods can be used. Write those names on the transparency with different colored markers. Possible answers are shown on this reduced image of Transparency 4. Note that several methods can be used in one area.

If students have difficulty starting, give this example. The Brookston soils have problems with seasonal high water. Drainage tile buried in these soils could help remove some of the water from those fields with Brookston soils.



Activity Master 18

Urban Soil Conservation Practices

Objectives

1. Students will describe soil conservation practices that are common in the urban environment. (Many of these soil-conserving methods also work in rural areas.)
2. Students will investigate their communities for soil conservation practices.
3. Students will recommend a conservation practice for problem areas that they find.
4. Students will recommend conservation practices for the areas illustrated in Transparency 4.

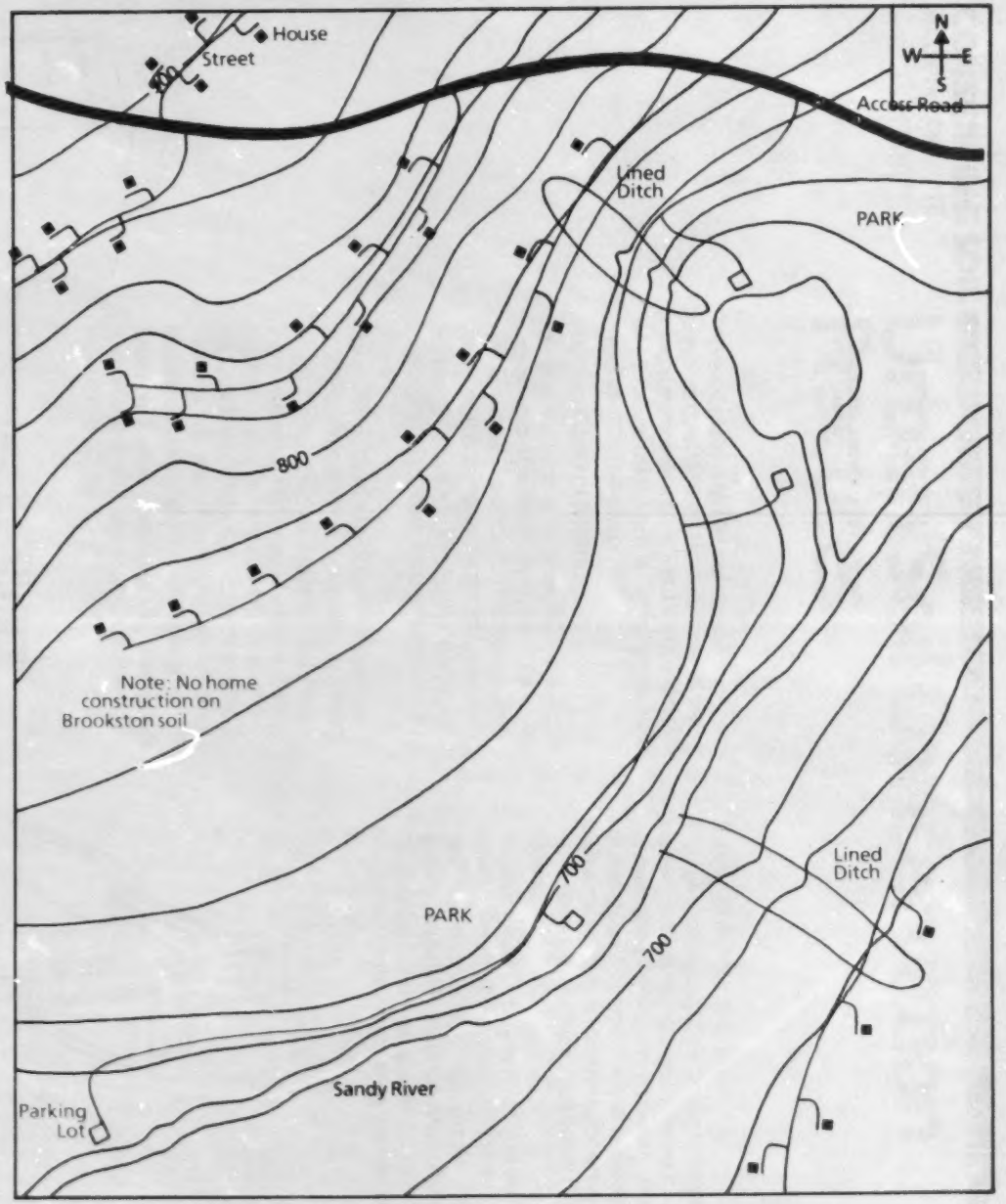
Supplies Needed: different color transparency markers

After students have read the activity sheet, review the urban soil conservation practices. Then project Transparency 4. It is a simplified topographic map of an undeveloped area with soil types (described in Activity Master 16) superimposed over the land features.

Explain to your students how to read the map. Point out the elevation contour lines, soil types, and other land features. State that the class has just been asked to design a suburb in this area. Ask students to give suggestions of where to locate a subdivision of homes (including streets and roads) and one or more parks, and to tell what soil conservation practices can be used during construction. They should refer to the soil chart in Activity 16 and the fact sheet in Activity 17 to make their land use decisions.

Ask your students to help design a housing subdivision. (Possible answers are shown on this reduced image of Transparency 4.) Draw the suburb—including streets and access roads—with a dark-colored marker on the transparency. Then draw one or more parks, using different colored markers. Continue down the list of urban conservation practices on the fact sheet. Ask your students to suggest where and how these methods can be used during or after construction. Write the names of these methods on the transparency. Note that several methods can be used in one area.

If students have difficulty starting, draw in the subdivision as shown on this reduced image and ask students why this is a correct land use.



Activity Master 19

Growing Enough Food: Maintaining Soil Productivity

Objectives

1. Students will determine how soil productivity is a major factor on our level of living.
2. Students will analyze those factors required to maintain soil productivity.
3. Students will list those practices of modern agriculture that both add to and detract from soil productivity.

Supplies Needed: none

To begin the lesson, ask your students to read the first paragraph, look at the charts, and read the first question. In the first question, students compute the percentage of change for each factor from 1950 to 1980. To do this, they simply divide the 1980 figure by the 1950 number, then multiply by 100. Explain the meaning of percent change to your students. Students fill in this number in the chart and answer the remaining questions.

To give a balanced view to this activity, explain that certain modern agricultural practices can lead to a loss of soil quality. Economics requires farmers to use larger equipment, buy more equipment, plow larger fields, and plant more row crops. This leads to increased erosion and possible soil compaction. State that an increase in the use of technology over the past 50 years has resulted in the increase in productivity. But soil quality has actually decreased.

Conclude the lesson by asking your students these questions: What do you think caused the decrease in the number of farm workers from 1950 to 1980? Make a prediction about the use of agricultural chemicals in the year 2000. What effect would continued soil degradation have on soil productivity? What effect could reduced soil productivity have on food prices? On supply? What effect would lowered soil productivity in the U.S. have on developing nations?

Growing Enough Food: Maintaining Soil Productivity

The United States exports more farm products than any other country on earth. Farmers can grow so much food because soils are very productive and because of technological improvements. (Productive soils can grow more food on an acre of land.)

Look at these three charts on soil productivity, then answer the questions below.

Chart 1: Factors Concerning Soil Productivity

Year	Index of Agricultural Chemicals Used* (1967 = 100)	Index of Farm Machinery Used (1967 = 100)	Acres Harvested (in millions of acres)	Agricultural Exports (in millions of dollars)
1950	29	84	345	$ 10.1
1980	174	128	353	$210.0
Percent of Change	+ 600%	+ 152%	+ 102%	+ 2079%

*Pesticides and Fertilizers

Chart 2: Percent of Farm and Non-farm Workers in the U.S.

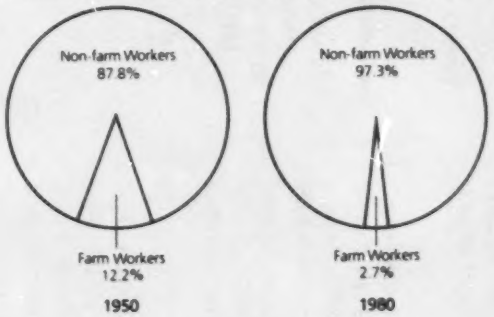


Chart 3: Cost of Food in Three Countries

	U.S.	Japan	Russia
Average % of family income used for food	17%	25%	50%

1. Figure the percentage of change for each factor from 1950 to 1980. Then place the answers at the bottom of the chart. (One has been done for you.)
2. Food production changed by + 150% from 1950 to 1980. Which of the factors increased food production the most? Agricultural chemicals
   The least? Acres harvested
3. Agricultural exports changed by + 2079% from 1950 to 1980. Food is our nation's largest export commodity.
4. Between 1950 and 1980, the percentage of farm workers decreased from 12.2% to 2.7%.
5. In 1980 a farm worker produced about six times more food for one hour's work than a worker in 1950. Why was this possible? More agricultural chemicals and more machinery were used.
6. Which country has the hardest time producing food? Russia Which produces food most easily? U.S.
7. Suppose your family earned $20,000 in a year. How much money might you pay each year for food in the U.S.? $3,400 In Japan? $5,000 In Russia? $10,000

Activity Master 20

Growing Enough Food: Disappearing Farmland

Objectives

1. Students will recognize that the irreversible loss of farmland to other uses is a national concern.
2. Students will compare land use in their communities now and in the past.
3. Students will discuss the interrelationships between disappearing farmland and world food supplies.

Supplies Needed: reference materials

Have your students read this activity and select the correct answers. After they have finished, read the statements and provide them with the correct choices. Emphasize the connection between the ability to meet the world demand for food and the loss of farmland. Point out that if we continue to lose our farmland, the United States may not be able to help feed the additional two billion people expected in the world by the year 2000. What might some of the consequences be if we cannot grow extra food for export?

Investigate how farmland is being lost in your area. You can easily tell by comparing current aerial photographs, soil survey maps, or land use maps with those that are ten, twenty, or thirty years old. Older land use maps can be found in old books about the history of your county. The maps and photos show how people use land at different points in time: for agriculture, for homes, for shopping areas, or for industry. By comparing the old and the new maps, you can tell how much land that was once used for farming is now used for something else.

Allow small groups of students to study the maps close up. Help them find their homes on current maps and that same area on older maps.

You could also have someone from your community come to your class and tell what the community was like 30 or 40 years ago.

Growing Enough Food: Disappearing Farmland

Fill in the blanks in the story from the list of words below. Each word is used only once. The sentence should give you enough clues to choose the right word.

Part 1

John Smith and his wife, Dawn, have been raising ___crops___ and ___livestock___ on their farm for many years. Now they are having a difficult time making a ___profit___. Their property ___taxes___ keep rising. The ___costs___ for farm machinery, fuel, and supplies are also rising. But the Smiths do not get paid much more for their ___harvest___. The Smiths are ___discouraged___ with farming.

At the same time, the ___suburbs___ are expanding. Home builders are hunting for more ___land___. The land is needed to build ___houses___, ___businesses___, ___factories___, and ___roads___.

A local ___builder___ made a good offer for their farm and the Smiths sold.

Part 2

Many other farmers face the same ___problems___ that the Smiths did. ___Rural___ areas are being changed into cities and suburbs. Every year we lose about 675,000 ___acres___ of cropland. We lose land to these competing uses ___reservoirs___, ___transportation___, ___airports___, and ___mining___. These types of losses are ___irreversible___. The land can never be used again for ___agriculture___.

In addition we lose ___forests___ and ___wetlands___ each year. This may make ___lumber___ and ___wildlife___ habitat scarce in the future.

We should not continue to ___lose___ farmland this fast. It will be more difficult to grow enough ___food___ for our use and for export.

~~builder~~	houses
~~businesses~~	roads
factories	suburbs
crops	land
harvest	taxes
profit	discouraged
~~costs~~	livestock

acres	mining
airports	problems
agriculture	reservoirs
food	rural
forests	transportation
irreversible	wetlands
lose	wildlife
lumber	

Activity Master 21

A Home for Wildlife

Objectives

1. Students will describe the role of food, water, and shelter in attracting wildlife into an area.
2. Students will conduct a survey to determine attitudes toward preserving wildlife habitat.
3. Students will seek information on what is being done in their communities to preserve habitat and attract wildlife.

Supplies Needed: none

Introduce this lesson by emphasizing that all animals need a place to live or they cannot survive. The location in which wildlife naturally exist, called a habitat, must have ample food, water, and shelter. The type of habitat varies from one organism to another. List several plants and animals on the board and ask your students to describe the habitat needed to survive.

Explain that the survey on the activity sheet has no correct answers. It is searching for personal opinions. Explain how to answer the statements, then have your students take the survey. Next students can have an adult take the survey.

Students should compute the average answer both for themselves and for adults. Compare the two averages. A lower average answer number reflects a general opinion that it is important to provide habitat for wildlife. Have students brainstorm any difference in average scores.

Conclude the activity by exploring what is being done in your state and community to preserve wildlife habitat. Have one student group write a letter to your state's department of natural resources. A second student group can prepare a letter for the local government. A third student group can get information from local conservation groups, such as local chapters of the Sierra Club, Audubon Society, or Izaak Walton League. Addresses of such groups can often be obtained from your local library or Chamber of Commerce. Ask each student group to report back to class.

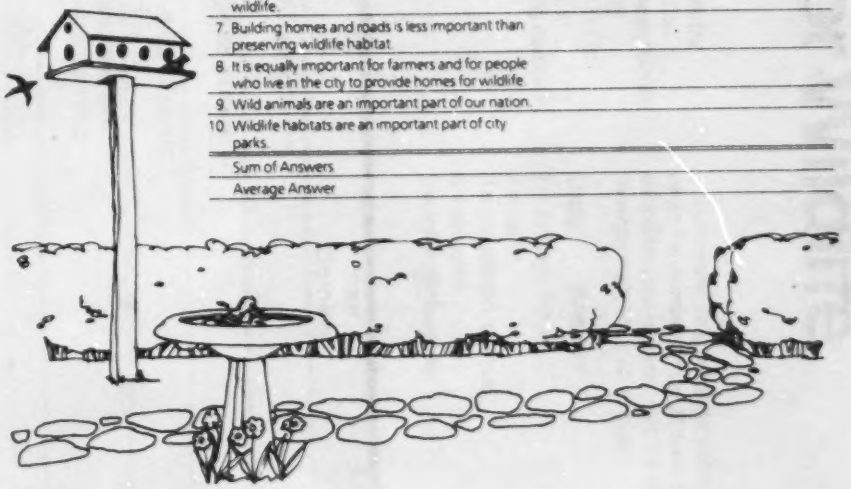
A Home for Wildlife

How important is it to preserve homes for wildlife? There are many answers to this question. Many of the answers are based upon personal opinions. Read the following statements. Then write your opinion in the space provided. Later play the role of a newspaper pollster and read the same question to an adult. (It could be a parent.)

Directions. First read the statement. Then write the number of the answer that best describes your opinion. Use the following number code for your answer.

Code Answer
1 = strongly agree
2 = agree
3 = no opinion, neutral
4 = disagree
5 = strongly disagree

	Your Opinion	An Adult's Opinion
1. We must provide a home for wildlife in our cities and on our farms.		
2. We should not build homes, factories, or roads in sensitive wildlife habitats.		
3. We should stop construction projects if they ruin the habitats of endangered wildlife.		
4. Backyards and school grounds are important places to plant trees and shrubs to attract birds and other wildlife.		
5. I like to watch birds and other wildlife.		
6. I want to do more to protect the habitats of wildlife.		
7. Building homes and roads is less important than preserving wildlife habitat.		
8. It is equally important for farmers and for people who live in the city to provide homes for wildlife.		
9. Wild animals are an important part of our nation.		
10. Wildlife habitats are an important part of city parks.		
Sum of Answers		
Average Answer		



Activity Master 22

Soil Pollution from Hazardous Chemicals

Objectives

1. Students will summarize why hazardous chemicals are so persistent in soils.
2. Students will describe how to prevent hazardous chemical pollution in their backyard, schoolyard, or other designated area.

Supplies Needed: warning labels from household products

To begin the activity, ask students to read the introductory material on the activity master. List the categories of hazardous chemicals on the board and ask students to give examples of each. Explain the term toxic and why it means more than poisonous. Then explain why they are persistent in soils, and how soils can become polluted. Next, have your students survey their homes for products that are hazardous. They should look for labels that contain words such as Caution, Danger, and Warning. Students should list these products on the activity master and then write the message from a warning label that they found. Discuss the need for such labels and the type of information that is on warning labels. Also mention that there are safer alternatives to many chemicals. Have your students research biological control of pests and other alternatives.

Calling on their background and experience, students will be able to evaluate the statements on the bottom of the activity master.

Television news programs and newspapers quite often cover a transportation accident that has resulted in a spill of hazardous chemicals. Have your students search for such news events and then report them to class. The class can also research what can be done to prevent such damages from occurring in the future.

Soil Pollution from Hazardous Chemicals

There are over 70,000 chemicals used in industry and at home. Some of these chemicals keep us healthy. Others are used to make the products we want. Many chemicals are needed to raise our food. About ten percent of all chemicals are harmful to human health and the environment. They are called hazardous chemicals. Hazardous chemicals are classified as flammable, corrosive, radioactive, explosive, and toxic.

Once in the environment, some hazardous chemicals remain there for years. They can become tightly bonded with soil clay particles. Organisms that live in the soil do not break down the chemicals easily. Neither does sunlight, heat, or moisture. In addition, hazardous chemicals can become stored in fat tissues of animals. This can contaminate food supplies. Animals higher up in a food chain (for instance, owls, fish, foxes, and people) can store more hazardous chemicals since they have a greater opportunity to eat contaminated food. To prevent these problems, we must use, store, and dispose of hazardous chemicals carefully. What are some of the hazardous chemicals that you use at home?

Check at home _____ _____

_____

Write down the warning label from a product that you think is hazardous _____

_____

Read these five statements. Then place a P if the statement is a proper way to use, store, or dispose of chemicals. Or place an I if it is an improper procedure. On the back of this sheet, tell how to correct any improper procedure.

I 1. Jack just changed the oil in his car. He dumped the waste oil into a ditch behind his house.

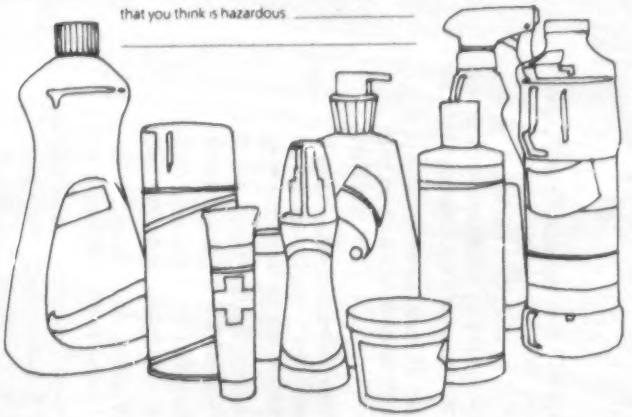
P 2. Sue uses a thick layer of mulch instead of herbicides to keep weeds from growing between the shrubs in her yard.

I 3. Bill uses insecticides to kill every spider and insect that he finds in his garden.

I 4. Beth leaves open containers of paint thinner and gasoline in her basement.

P 5. Amy keeps most of her household chemicals locked in a cabinet.

I 6. Fred empties a bottle of an unknown chemical on the ground behind his garage.



Activity Master 23

Surface Mining and Reclamation

Objectives

1. Students will explain soil and water degradation that can result from improperly reclaimed surface mines.
2. Students will describe how proper reclamation reduces soil and water degradation.
3. Students will identify the costs and benefits of proper reclamation.

Supplies Needed: none

Begin the lesson by defining the terms surface mining and reclamation to your students. Surface mining refers to the practice of removing mineral resources that are at or just beneath the surface of the ground. It is also called strip mining. Reclamation is the process of restoring surface-mined areas back to the condition they exhibited before mining.

Your students should have little trouble in ordering the steps of reclamation listed on the activity sheet. However, they will probably need help telling why each step is important. Divide your class into four groups. Each group can research one of the steps and report back to class.

To do the second part of the activity, students will need to understand the concepts of benefits and costs as they apply to a reclamation project. Benefits are the positive features that result from reclamation. They can involve environmental benefits—reducing levels of pollution, returning the land to productive use, or creating recreation opportunities. Another type of benefit is the value (in dollars) obtained from the renewed productivity of the land. This is an economic benefit.

Costs are construction expenses for equipment, personnel, and supplies needed to carry out the project. (These can be called economic costs.) Costs can also refer to the damage to the environment that could occur if the project was not carried out or if it is not properly done. (These can be called environmental costs.) In the case of mine reclamation, damages could be the erosion and water pollution, and the destruction that could result from flooding in communities downstream from the project. Other damages include loss of recreational opportunities or the loss of land from agricultural use.

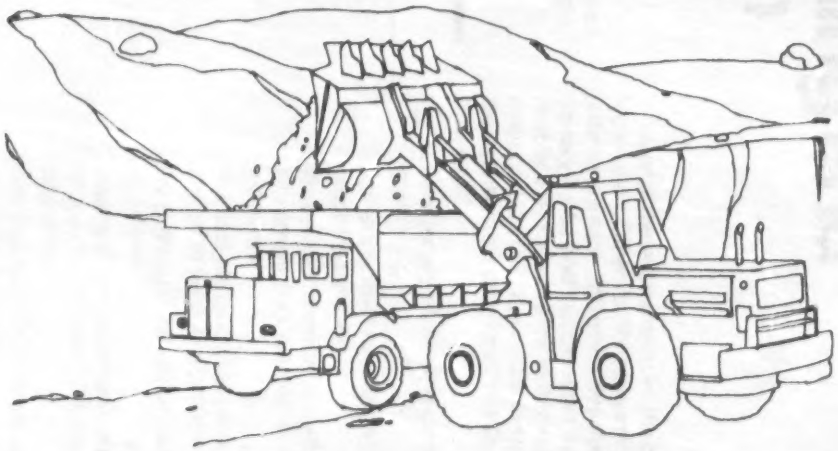
Surface Mining and Reclamation

This chart outlines the steps involved in reclaiming a surface mine. The order is scrambled. First read each sentence. Then place a number in the first column showing the right order. Complete the chart by telling why each of the steps is important. You may need textbooks or other books for help.

Order	Description of Reclamation Step	Why Is This Step Important?
4	Plant a cover crop of grasses or native trees and shrubs.	To reduce soil erosion and put the land into productive use.
1	Push the rocks and soil into the mine.	To bury large boulders and rocks and to reduce the problem of acids draining from the mine.
3	Spread topsoil over the area.	To place a layer of productive soil over sterile rocks and subsoil.
2	Smooth over the area to nearly the original shape.	To eliminate deep holes and steep cliffs and make area scenic.

Some of these statements list the benefits of reclamation. Others list the economic costs of reclaiming a mine. Still others describe the damage to the land that can result from no reclamation. You can think of this as an environmental cost. Place a B in the space by the statement if it describes a benefit. Place a C if it is a cost.

C 1. If not reclaimed, the land cannot be used again.
B 2. Soil erosion is almost stopped with proper reclamation.
C 3. Reclamation needs large earthmoving equipment, fuel, and people to run the machines.
B 4. The land can be used as pasture for cattle and other livestock if properly reclaimed.
B 5. Parks and golf courses can be built after reclamation.
C 6. Nearby water can become polluted with erosion and acids with improper reclamation.
C 7. The price of mined minerals will go up as a result of reclamation.



Activity Master 24

Recycling Organic Wastes

Objectives

1. Students will restate the sources of organic wastes that must be disposed.
2. Students will describe the advantages and disadvantages of the recycling of organic wastes.

Supplies Needed: none

Begin the lesson by describing the concept of recycling. Then describe organic wastes to your students.

Recycling, in this example, refers to the following sequence: 1) Food is grown in soil. 2) The food is used. 3) Food and other organic waste products are then returned to soils as organic wastes. 4) Soil organisms break down the organic wastes into the nutrients. 5) The nutrients are used by new plants as they grow.

Organic wastes are called sludges by industry. They are the liquid, semi-solid, and solid materials that are, for example, left over from food processing and sewage treatment. These sludges are loaded onto trucks. Often the trucks drive onto fields before planting, onto pastures, or onto reclaimed surface mines. The trucks spray or apply the wastes in even and specified amounts on the soil.

Have your students read the activity and answer the questions. Review your students' answers.

You may wish to explain composting of household wastes to your students. This is a practical alternative to waste disposal and recycling that your students can do at home. Several references are listed in the resource guide. Your students could also research the methods of municipal solid waste disposal that are used in your community.

Conclude the lesson by asking your students to categorize the facts as advantages or disadvantages to the recycling of organic wastes. All of the facts except 6, 7, and 8 are advantages.

Recycling Organic Wastes

Read these facts about organic waste recycling. Then use the facts to answer the true-or-false questions. In the blank after each answer, write the number(s) of statements you used to reach your answer.

1. Organic matter is a valuable ingredient in soil. Farm soils are gradually losing organic matter.
2. The topsoil used to reclaim surface mines should have a large amount of organic matter.
3. Sewage treatment plants are a source of organic wastes that must be disposed.
4. Food processors and other companies are a source of organic wastes that must be disposed.
5. It is possible to recycle many organic wastes. We can spread them on the land to add organic matter to the soil.
6. It is too expensive to spread organic wastes on land that is far away from a source.
7. Hazardous chemicals and heavy metals (such as mercury, copper, and lead) can pollute organic wastes.
8. Polluted organic wastes are a health hazard when spread on farm fields.
9. We can test organic wastes for pollution before they are spread on fields.
10. We will benefit if we recycle organic wastes carefully.

True or False	Facts	
F	7,8	a. All organic wastes are safe to use on corn fields.
T	1,9,10	b. Pollution-free organic wastes can help farmers build up their soils.
F	3,4	c. Large cities do not make enough organic wastes.
T	2	d. Reclaimed mines are a good place to spread organic wastes.
F	5,9,10	e. It is better to dump organic wastes into a landfill. It is too hard to spread them on fields.
T	6	f. A California farmer could not use wastes from a food company in Ohio.
F	9,10	g. Recycling organic wastes will not be an important disposal technique. The pollution problem is too great.